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NOTE. — This Society is not responsible for any statement made or opinion expressed in its publications.

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ABBREVIATIONS. — D. = Discussion; I. = Illustrated.
Names of authors are printed in *italics*.

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BOSTON SOCIETY OF CIVIL ENGINEERS
FOUNDED 1848

PROCEEDINGS

NOTICE OF REGULAR MEETING.

A REGULAR meeting of the Boston Society of Civil Engineers will be held on

WEDNESDAY, JANUARY 27, 1915,

at 7.45 o'clock P.M., in CHIPMAN HALL, TREMONT TEMPLE, BOSTON.

Business of the Meeting: To choose a committee of five to nominate officers for the ensuing year.

Mr. Nathan H. Daniels, member of the American Institute of Electrical Engineers, will read a paper entitled "Insurance as an Aid to Engineers."

S. E. TINKHAM, *Secretary.*

PAPERS IN THIS NUMBER.

"The Commission-Manager Form of Government and Its Relation to the Engineering Profession." Henry M. Waite.

(Presented November 18, 1914.)

Discussion of "The Mechanics of Reinforced Concrete," with Author's Closure.

CURRENT DISCUSSIONS.

Paper.	Author.	Published.	Discussion Closes.
"Phosphate Rock Industry."	L. W. Tucker.	Dec.	Feb. 10.
"Power Plant at Wachusett Dam."	Thayer and Allardice.	Dec.	Feb. 10.

FEBRUARY MEETING OF THE SANITARY SECTION.

A SPECIAL meeting of the Sanitary Section will be held Wednesday evening, February 3, 1915, in the library of the Society, Tremont Temple, at 7.45 o'clock.

The subject of the meeting will be "Garbage Disposal."

Dr. Frederic Bonnet, Jr., Professor of Chemistry at the Worcester Polytechnic Institute, will present a paper on "Garbage Disposal at Worcester, Mass.," illustrating it with lantern slides.

Mr. W. J. Springborn, manager of the New Bedford Extractor Company, will speak on the new plant for garbage treatment now in operation at New Bedford, Mass.

Others have been invited to participate in the discussion.

FRANK A. MARSTON, *Clerk.*

MINUTES OF MEETINGS.

BOSTON, December 16, 1914. — A regular meeting of the Boston Society of Civil Engineers was held this evening at Chipman Hall, Tremont Temple, and was called to order at 7.50 o'clock by the President, Mr. Harrison P. Eddy, who introduced as the presiding officer Vice-President Charles R. Gow. There were present 92 members and visitors.

By vote the reading of the record of the last meeting was dispensed with, and it was approved as printed in the December JOURNAL.

The Secretary reported for the Board of Government that it had elected the following to membership, in the grades named:

Members: John Patrick Cronin, Allan Curtis, Eric Lars Johnson, Walton Harvey Sears and Burdett Cardale Thayer.

Juniors: William Rea Holway, Carl Louis Stucklen and Carl Wilbur Wood.

The Vice-President announced the death of Lucian A. Taylor, a member of the Society, which occurred November 19, 1914, and by vote the President was requested to appoint a committee to prepare a memoir. The committee appointed consists of Messrs. Wm. E. McClintock and Frank E. Hall.

Vice-President Gow stated that the subject of the evening was " The Hydro-Electric Power Plant at the Wachusett Dam, Clinton, Mass.," and introduced the authors, Mr. Elliott R. B. Allardice and Mr. Burdett C. Thayer. The paper was read by Mr. Allardice, and Mr. Thayer explained the stereopticon views thrown on the screen. The lantern used was one which had recently been presented to the Society by Mr. John R. Freeman, one of the past presidents.

At the conclusion of the reading of the paper, a most interesting discussion took place, in which the following gentlemen took part: Frederic P. Stearns, Dexter Brackett, Harold K. Barrows, Charles M. Allen, Ira W. McConnell, William L. Puffer, Alfred O. Doane and Frank B. Sanborn.

Adjourned.

S. E. Tinkham, *Secretary.*

Sanitary Section.

Boston, Mass., November 27, 1914. — A special meeting of the Sanitary Section of the Boston Society of Civil Engineers was held this evening in the library of the Society, Tremont Temple.

The meeting was called to order at 7.50 o'clock by Chairman Bertram Brewer, who introduced the speaker of the evening, Mr. Langdon Pearse, Division Engineer of the Sanitary District of Chicago.

Mr. Pearse gave a very interesting talk on " The Industrial Wastes of Chicago, with Particular Reference to the Packing Industry." Lantern slides were used to illustrate his remarks.

The meeting passed a vote of thanks to Mr. Pearse for his courtesy in addressing the Section during his brief stay in Boston.

There were 55 present at the meeting.

The new projection lantern presented to the Society by Mr. John R. Freeman was used for the first time in a meeting of the Society.

FRANK A. MARSTON, *Clerk.*

BOSTON, MASS., December 9, 1914. — The December meeting of the Sanitary Section of the Boston Society of Civil Engineers was held this evening in the library of the Society, Tremont Temple. The meeting was opened at 8 o'clock P.M. by Chairman Bertram Brewer.

The records of the May meeting and of the June excursion were approved as printed in the JOURNAL. The record of the November special meeting was read and approved.

The report of the special committee on " Toilet Regulations for Industrial Establishments " was presented by Robert Spurr Weston, chairman. After giving a brief discussion of the work done by the committee, Mr. Weston read a letter from Mr. T. Howard Barnes suggesting certain modifications in the proposed " Regulations." Mr. George A. Carpenter, a member of the special committee, read a letter from a prominent manufacturer expressing approval of the committee's report.

The Regulations were discussed and a number of changes made. The adopted regulations will be published in the February issue of the JOURNAL.

A copy as adopted has been forwarded as directed, and receipt thereof acknowledged by the Commissioner of Labor and Industries.

Following the business meeting, Mr. Harrison P. Eddy, president of the Society, presented a paper on " The Economic Depth of Trickling Filters." A paper was also presented by Mr. H. W. Clark, chief chemist to the Massachusetts State Department of Health, on " A Study of Depth of Filter Material in Connection with Trickling Filter Efficiency."

There were 48 present at the meeting.

Meeting adjourned at 10.20 o'clock.

FRANK A. MARSTON, *Clerk.*

BOSTON, MASS., January 6, 1915. — A special meeting of the Sanitary Section of the Boston Society of Civil Engineers was held this evening in the Society library, Tremont Temple.

The meeting was opened at 8 o'clock by the Chairman.

Pursuant to instructions from the Executive Committee, the Chairman announced the appointment of a special committee to study and report on "Methods of Design and Construction and Results of Operation of Submerged Pipe Lines for Outfall Sewers," as follows: Hiram A. Miller, chairman; DeWitt C. Webb, George A. Sampson, Edgar S. Dorr.

The Chairman then introduced Dr. J. W. M. Bunker, of the Sanitary Engineering Department, Harvard University, who gave an exceedingly interesting description of the forms and characteristics of "Diatoms." His talk, although of a popular nature, proved an admirable introduction to the collection of drawings, photographs and microscopic slides exhibited by Mr. F. F. Forbes, Superintendent of the Water Department of Brookline, Mass.

A vote of thanks was offered to Dr. Bunker and Mr. Forbes for their courtesy in presenting the subject of the evening in such an interesting manner.

There were 56 present. Meeting adjourned at 9.35 o'clock.

This meeting demonstrated in a new way the value and completeness of the stereopticon presented to the Society by Mr. Freeman, for without it the meeting would not have been possible. All of the objects were projected with clearness and in considerable detail.

FRANK A. MARSTON, *Clerk.*

MR. C. A. P. TURNER, whose paper on "The Mechanics of Reinforced Concrete" appeared in the issue of the JOURNAL for September, 1914, has presented to the Society a copy of a treatise entitled "Concrete-Steel Construction." This book, which was written jointly by Mr. Turner and Dr. Henry T. Eddy, was sent for the convenient reference of those who wish to study the subject more at length after reading the discussion of his paper.

APPLICATIONS FOR MEMBERSHIP.

[January 11, 1915.]

THE By-Laws provide that the Board of Government shall consider applications for membership with reference to the eligibility of each candidate for admission and shall determine the proper grade of membership to which he is entitled.

The Board must depend largely upon the members of the Society for the information which will enable it to arrive at a just conclusion. Every member is therefore urged to communicate promptly any facts in relation to the personal character or professional reputation and experience of the candidates which will assist the Board in its consideration. Communications relating to applicants are considered by the Board as strictly confidential.

The fact that applicants give the names of certain members as reference does not necessarily mean that such members endorse the candidate.

The Board of Government will not consider applications until the expiration of twenty (20) days from the date given.

APPLETON, ARTHUR BENSON, Beverly, Mass. (Age 28, b. Beverly, Mass.) Educated in Beverly public schools and Mass. Inst. of Tech., where he was a student for three years. From 1907 to 1909, survey and office work with Mr. Wm. S. Johnson, civil engineer, Boston; from 1910 to 1912, with E. L. Ransome on construction work, and with State Board of Health on survey work, Neponset River; from 1912 to 1914, with Mass. Highway Comm. on estimating, designing and checking of reinforced concrete bridges, also computing and drafting; from 1914 to date, with city engineer, Lynn, Mass., in charge of party. Refers to C. B. Breed, H. P. Burden, J. L. Howard, W. S. Johnson, R. H. Sutherland and W. L. Vennard.

BUCKLEY, WM. JOSEPH, Lynn, Mass. (Age 35, b. Lynn, Mass.) Graduate Mass. Inst. of Tech., 1912, civil engineering course. From July to Oct., 1909, rodman, U. S. Engineer's Office, Boston; from March to June, 1910, rodman with B. & M. R. R.; from June to Oct., 1910, rodman with N. Y. C. & H. R. R. R., construction dept.; from July to Oct., 1911, recorder, U. S. Engineer's Office, sounding and boring of Boston Harbor; from Oct., 1912, to April, 1913, timekeeper, Lucius Engrg. Co., Pittsburg, Pa., on bridge erection; from April to June, 1913, rodman with Boston Transit Comm., on East Boston Tunnel Extension; from June, 1913, to Nov., 1914, foreman, paymaster and timekeeper, Lucius Engrg. Co., on bridge construction. Refers to C. F. Allen, C. B. Breed, L. E. Moore and C. M. Spofford.

Corey, Kenneth Tolman, Pittsfield, Mass. (Age 26, b. Springfield, Mass.) From Sept., 1907, to June, 1909, general assistant with Geo. N. Merrill & Co., Springfield, Mass.; from June, 1909, instrumentman with Meikleham & Dinsmore of New York; from March, 1910, to date, engineer in charge and resident engineer with Durkee, White & Towne, Springfield. Refers to R. H. Barnes, F. P. Cobb, F. B. Locke, A. E. Tarbell.

Cowles, Martin Warren, Fairfield, Conn. (Age 21, b. New Haven, Conn.) Senior at Mass. Inst. of Tech., sanitary engineering course; two months at Surveying Camp, Maine. Refers to C. F. Allen, C. B. Breed, A. E. Burton, Dwight Porter, A. G. Robbins and C. M. Spofford.

Dowst, Everett Frank, Concord, N. H. (Age 26, b. Allentown, N. H.) Graduate of Norwich Univ., Northfield, Vt., 1912, civil engineering course. From July to Dec., 1912, draftsman with Southern New England R. R. Corp'n, Nashua, N. H.: Jan., 1913, chainman, Boston, Revere Beach & Lynn R. R.; from Feb. to Aug., 1913, chainman, B. & M. R. R.; from Sept., 1913, to Jan., 1914, transitman, N. H. State Highway Dept.; from April, 1914, to date, in private practice connected with Storrs Engineering Co., Concord, N. H. Refers to W. B. Howe, F. W. Lang, E. D. Storrs and J. W. Storrs.

Eisnor, John James, Boston, Mass. (Age 28, b. Lunenburg, N. S.) Graduate of Dalhousie Univ.; received diploma from H. Park College, Des Moines, Ia., 1913. Before graduation from Dalhousie, was for two years with N. Trans. R. R.; was for about four years with F. C. Wales, C.E.; 1911, transitman on assessors' survey, town of Marion; also in charge of building pier for Chas. S. Hamblin, Mattapoisett, and laid out and inspected work on William Strong's summer home at Woods Hole; 1912, transitman and inspector on $12 000 improvement of Henry Fay estate, Cape Cod; 1913, resident engineer and inspector on reinforced concrete bridge at Osterville, Mass.; transitman and inspector on Woods Hole drawbridge and sea wall, and superintendent for Taylor & Crosby Constr. Co. on concrete bridge; is at present with New England Gas and Coke Co. Refers to W. H. Cheney, W. E. McKay, D. S. Reynolds and J. C. S. Taber.

Hall, Charles Loring, Dorchester, Mass. (Age 21, b. Dorchester, Mass.) Student at Mass. Inst. of Tech., Class of 1915, civil engineering course. Refers to C. F. Allen, C. B. Breed, G. L. Hosmer, J. W. Howard and C. M. Spofford.

Harris, Gilbert Munday, Newton, Mass. (Age 26, b. Boston, Mass.) Received technical education chiefly at Boston Y. M. C. A. evening school and Franklin Union; student for one-half year at Tufts College, engineering course. From April, 1910, to Sept., 1911, rodman with B. & M. R. R.; from Sept. to Nov., 1911, with Mt. Washington Electric R. R. preliminary and location surveys; from Dec., 1911, to April, 1912, with Edison Co., St. Engrg. Dept.; from April to May, 1913, with B. & M. R. R., Real Estate Engrg. Dept., as transitman; from July to Oct., 1913, with the National Highway Association at South Yarmouth, Mass.; from Dec., 1913, to Feb., 1914, with Boston Finance Comm.; from March, 1914, to date, title

researchman in Valuation Engineering Dept. of B. & M. R. R. Refers to C. H. Davis, G. W. Cutting, Jr., T. P. Perkins, C. H. Restall and F. B. Rowell.

HUBBARD, CARL PERRY, Woburn, Mass. (Age 27, b. Somerville, Mass.) Graduate of Tufts College, 1909, civil engineering course. From July, 1909, to Jan., 1910, inspector on reinforced concrete for Adolf Such, Hyde Park, Mass.; from Jan., 1910, to Sept., 1911, foreman, time-keeper and job superintendent with Aberthaw Const. Co., Boston; from Sept., 1911, to May, 1912, estimator and engineer with L. D. Willcutt Sons' Co., Boston; from May, 1912, to July, 1914, resident engineer on reinforced concrete work with Lockwood, Greene & Co., Boston; from July, 1914, to date, superintendent of construction camp, state of Wisconsin. Refers to L. H. Allen, J. A. Garrod, F. W. Reynolds, E. H. Rockwell, F. B. Sanborn and L. C. Wason.

KING, ARTHUR CASWELL, Springfield, Mass. (Age 30, b. Taunton, Mass.) Graduate of Brown Univ., 1906, degree of B.S. in civil engineering. During summers of 1900 and 1901, rodman on preliminary surveys and inspector of sewer construction, also instrumentman on private land surveying, Taunton; during summer of 1905 and from 1906 to 1907, assistant, engineering dept., Mass. State Board of Health; from Feb., 1907, to date, with Springfield, Mass., Water Dept., as draftsman, instrumentman, estimator, inspector, assistant engr. in charge of party on land surveys and finally, since April, 1911, as superintendent's assistant; is also in charge of office at service building. Refers to H. K. Barrows, C. R. Gow, G. A. Carpenter, G. A. King, W. S. Johnson and E. E. Lochridge.

NICHOLS, JOHN ROBERT, Cambridge, Mass. (Age 31, b. Somerville, Mass.) Graduate of Harvard College, 1906, degree of A.B.; course included engineering work chiefly. From Aug., 1906, to Feb., 1907, draftsman and reinforced concrete designer with contractor in Montreal; from Feb., 1907, to Dec., 1908, draftsman and reinforced concrete designer with Eastern Concrete Const. Co., Boston; from Feb. to July, 1909, with H. P. Converse & Co., on reinforced concrete design and estimate; from Sept., 1909, to June, 1913, instructor in civil engineering, Harvard Univ.; occasional consulting work; since June, 1913, engineer with Monks & Johnson, Boston, on design, detail and estimate of structures, mostly buildings, in reinforced concrete, wood and steel; Assoc. M. Am. Soc. C. E. Refers to Granville Johnson, L. J. Johnson, Mark Linenthal, C. E. Nichols, J. B. Newton and E. F. Rockwood.

O'NEIL, THOMAS P., Cambridge, Mass. (Age 39, b. Cambridge, Mass.) Educated in Cambridge public schools. From 1893 to 1900, brick mason; from 1900 to 1903, foreman mason; from 1903 to 1912, general contractor; from 1912 to date, supt. of sewers, Cambridge. Refers to W. A. Ford, Hugh Nawn, C. V. Reynolds and J. M. Wiseman.

SMITH, FREDERICK DEXTER, Malden, Mass. (Age 51, b. Foster, R. I.) Graduate of Mass. Inst. of Tech., civil engineering course, class of 1893. Since June, 1893, has been employed by Metropolitan Sewerage Comm., as assistant engineer, division engineer, and finally engineer in charge of Metro-

politan Sewerage Works. Refers to Dexter Brackett, H. A. Carson, F. H. Fay, C. R. Gow, C. M. Spofford and J. R. Worcester.

SUMNER, MERTON ROGERS, Hopedale, Mass. (Age 28, b. South Paris, Me.) Graduate of Univ. of Maine, degree of B.S. in civil engineering. From June to Sept., 1911, with Stone & Webster, as student; from Sept., 1911, to Jan., 1912, instrumentman and assistant to resident engineer on electric inter-urban railway construction in Texas; from Jan., 1912, to July, 1912, inspector on contract timber work; from July to Nov., 1912, foreman of bonding work, using welded bonds of the E. Ry. I. Co., Cleveland, Ohio; from Nov., 1912, to Feb., 1913, transitman on hydro-electric power development, Big Creek, California; from Feb. to Mar., 1913, transitman on construction of Dam No. 3, Big Creek development; from March to May, 1913, chief inspector on construction of reinforced concrete intake and gate tower; rom May to June, 1913, chief power-house inspector on construction of power house No. 2; from June, 1913, to date, assistant engineer with Draper Co., Hopedale, Mass. Refers to W. A. Cobb, W. J. Dotten, F. A. Marston, J. P. Wentworth and H. A. Boardman.

SWATY, DAVID Y., Newtonville, Mass. (Age 37, b. Algoma, Wis.) Graduate of Univ. of Wisconsin, 1898, civil engineering course. From 1898 to 1899 with Philadelphia firm, as inspector of structural steel at mills and bridge shops; from Aug., 1899, to Jan., 1903, inspector of structural steel, draftsman, transitman, etc., with chief engr., Pennsylvania Lines West of Pittsburg; from Jan., 1903, to Sept., 1905, assistant engineer, M. of W., Southwest System Pennsylvania Lines West of Pittsburg; from Sept., 1905, to Nov., 1911, assistant engineer, M. of W., Northwest System Pennsylvania Lines West of Pittsburg; from Nov., 1911, to date, contracting engineer with Great Lakes Dredge & Dock Co. Refers to A. E. Hatch, L. E. Moore and L. G. Morphy.

LIST OF MEMBERS.

ADDITIONS.

HOLWAY, WILLIAM R. .... 28 Bickerstaff St., Boston, Mass.
JOHNSON, ERIC L. .... 60 Clifton St., Dorchester, Mass.
WALDSTEIN, JULIUS .... 317 Tremont Bldg., Boston, Mass.

CHANGES OF ADDRESS.

BESSEY, ROY F. .... 3109 Clarendon Road, Brooklyn, N. Y.
BRUNEL, RICHARD .... 39 Cedar St., Portland, Me.
ENEBUSKE, CARL C. .... Augustana College, Rock Island, Ill.
FERGUSON, JOHN N. .... Ponkapoag, Mass.
MORRILL, F. P. .... 28 Eliot St., Watertown, Mass.
NEGUS, ARTHUR I. .... 117 Myrtle St., Melrose, Mass.
PETTEE, EUGENE E. .... 493 Commercial St., Portland, Me.

Powers, Charles F. . . . . 27 Hollingsworth St., Mattapan, Mass.
Preble, J. Jarvis. . . . . 45 Rich St., Waltham, Mass.
Rice, Arthur P. . . . . 34 Chestnut St., Everett, Mass.
Robinson, Ashley Q. . . . . Room 9, Horton Block, Attleboro, Mass.
Saville, Charles. . . . . 3803 Gaston Ave., Dallas, Tex.
Sears, Calvin C. . . . . Box 13, East Dennis, Mass.
Simpson, E. Roland . . . . 176 Federal St., Boston, Mass.
Sokoll, Jacob M. . . . . 878 Dixwell Ave., New Haven, Conn.
Waring, Charles T. . . . . Buzzards Bay, Mass.
Wentworth, John P. . . . . 7 Park Ave., Malden, Mass.
Wiseman, John M. . . . . 15 Beacon St., Boston, Mass.

DEATH.

Cochrane, Clifford N. . . . . Died August 8, 1914

EMPLOYMENT BUREAU.

The Board of Government maintains an employment bureau for the Society, to be a medium for securing positions for its members and applicants for membership, and also for furnishing employees to members and other desiring men capable of filling responsible positions.

At the Society room two lists are kept on file, one of *positions available* and the other of *men available*, giving in each case detailed information in relation thereto.

Men Available.

239. Age 43. Educated in Boston public schools and Mass. Agricultural College. Experience includes five years with distribution department of Metropolitan Water Board on pipe line surveys and construction, five years in city engineer's office, Waterbury, Conn., on drafting, computation surveys and construction, mill work and installation of septic tanks; and eight years with Board of Water Supply of New York City on Hudson River Crossing of Catskill Aqueduct; was assistant to division engineer on this work for six years and in direct charge for two years, when work was completed; has also had experience in engineering work for Bay State Street Railway Co., Underground Dept. Particularly desires position in Boston.

278. Age 20. High school graduate and student for one-half year at Boston Y. M. C. A. Co-operative Engineering School. Has had no practical experience. Is willing to start at small salary with opportunity to learn and advance.

279. Age 38. Has had nineteen years' experience as draftsman, designer, etc., on various kinds of industrial plants and their equipment, including reinforced concrete and steel mill construction; has had special training in dye-house work for woolen and worsted mills. Desires position as draftsman. Salary desired, $5 per day.

280. Age 25. Student for four years at universities of Valparaiso and Wisconsin. Experience includes five field seasons on topographic mapping with U. S. Geological Survey; six months as draftsman with Lynn Water Department, and two seasons as rodman and inspector with B. & M. R. R. Desires position as engineer or draftsman; would take temporary position. Salary desired, $80 per month.

281. Age 38. Educated in public schools of Boston and at Tufts College in scientific course. Experience includes two years on highway construction; two years in mining engineering; five years on river and harbor improvement and ten years as designer, estimator, etc., on sewerage work, including office experience as assistant engineer. Desires position as inspector or as assistant in field or office. Salary desired, $150 per month.

282. Age 37. Student for five years in evening engineering classes of Boston Y. M. C. A. Has had fifteen years' engineering experience, including designing of special tools and machinery and improving of factory equipment and systems for General Electric Co., detailing and layout of industrial and power plants and designing of structural steel for various architects and engineering firms. Desires immediate engagement at reasonable salary.

283. Age 31. Student for two years at Norwich Univ., Vermont, civil engineering course. Has had about five years' experience as designer and draftsman, also two years' practical experience in foundry; is familiar with all kinds of mathematical computations, including higher mathematics; good detailer and designer on steel and reinforced concrete. Desires a permanent position as steel designer. Salary desired, $25 per week.

LIBRARY NOTES.

Recent Additions to the Library.

U. S. Government Reports.

Annual Report of Interstate Commerce Commission for 1914.

Annual Report of Secretary of Commerce for 1914.

Annual Report of Superintendent U. S. Coast and Geodetic Survey for 1914.

Production of Asphalt, Related Bitumens, and Bituminous Rock in 1913. David T. Day.

Basket Willow Culture. George N. Lamb.

Chinese and Japanese in United States in 1910.

Statistics of Clay-Working Industries in United States in 1913. Jefferson Middleton.

Hints on Coal-Mine Ventilation. J. J. Rutledge.

Production of Cobalt, Molybdenum, Nickel, Tin, Titanium, Tungsten, Radium, Uranium and Vanadium in 1913. Frank L. Hess.

Contributions to Economic Geology, 1912. Part II. — Mineral Fuels. Marius R. Campbell.

Contributions to Stratigraph of Southwestern Colorado. Whitman Cross and Esper S. Larsen.

Copper in 1913. B. S. Butler.

Supply and Distribution of Cotton, 1914.

Statistics of Express Companies in United States, 1912.

Fuel in Briquetting in 1913. Edward W. Parker.

Gems and Precious Stones in 1913. Douglas B. Sterrett.

Gold, Silver, Copper, Lead and Zinc in California and Oregon in 1913. Charles G. Yale.

Gold, Silver, Copper, Lead and Zinc in Utah in 1913. V. C. Heikes.

Gold, Silver, Copper, Lead and Zinc in New Mexico and Texas in 1913. Charles W. Henderson.

Humidity of Mine Air. R. Y. Williams.

Production of Iron Ore, Pig Iron and Steel in 1913. Ernest F. Burchard.

Lead in 1913. C. E. Siebenthal.

Production of Metals and Metallic Ores in 1912 and 1913. J. P. Dunlop.

Mineral Resources of Alaska, 1913. Alfred H. Brooks and others.

Montana Group of Northwestern Montana. Eugene Stebinger.

Moorcroft Oil Field and Big Muddy Dome, Wyoming. V. H. Barnett.

Constitution of Natural Silicates. Frank Wigglesworth Clarke.

Norway Pine in Lake States. Theodore S. Woolsey, Jr., and Herman H. Chapman.

Study of Oxidation of Coal. Horace C. Porter and O. C. Ralston.

Ore Deposits in Sawtooth Quadrangle, Blaine and Custer Counties, Idaho. Joseph B. Umpleby.

Phosphate Deposits of South Carolina. G. Sherburne Rogers.

Precise Leveling from Brigham, Utah, to San Francisco, Cal. William Bowie.

Prevention of Accidents from Explosives in Metal Mining. Edwin Higgins.

Primary Triangulation on One Hundred and Fourth Meridian, and on Thirty-Ninth Parallel in Colorado, Utah and Nevada. William Bowie.

Production of Platinum and Allied Metals in 1913. David T. Day.

Quarry Accidents in United States in 1913. Albert H. Fay.

Reconnaissance in Canyon Range, West-Central Utah. G. F. Loughlin.

Results of Spirit Leveling in Hawaii, 1910 to 1913 inclusive. R. B. Marshall.

Slate in United States. T. Nelson Dale and others.

Taxation and Revenue Systems of State and Local Governments, 1912.

Water-Supply Papers 332-C, 340-C, D and E, 344, 363 and 364.

State Reports.

Massachusetts. Report of Directors of Port of Boston on Fish as a Food or Fish against Meat.

Massachusetts. The Port of Boston, U. S. A.

Pennsylvania. Reports of Water Supply Commission for 1910–12 inclusive. Gift of Desmond FitzGerald.

City and Town Reports.

Boston, Mass. Larger Aspects of Passenger Transportation in Metropolitan Boston.

Cambridge, Mass. Annual Report of City Engineer for 1913.

Concord, N. H. Report on Water Supply. G. C. Whipple.

Detroit, Mich. Annual Report of Department of Parks and Boulevards for 1913.

Detroit, Mich. Annual Report of Water Commissioners for 1913–14.

Northampton, Mass. Annual Reports of City Officers for 1913.

Miscellaneous.

American Society for Testing Materials. Proceedings for 1914. Gift of L. C. Wason.

Encyclopædia Britannica, Ninth Ed., Vols. I to XXV inclusive.

Canada, Dept. of Mines. Production of Coal and Coke in Canada in 1913, by John McLeish; Report on Building and Ornamental Stone of Canada, Vol. II, by William A. Parks; Gypsum in Canada, by L. H. Cole.

Cape Cod and Its Canal. J. W. Miller.

The Cape Cod Canal. August Belmont.

The Cape Cod Canal. A. St. Clair Smith.

Concrete-steel Construction. Part I. Buildings. Henry T. Eddy and C. A. P. Turner. Gift of latter.

Conditions and Outlook of the Big New Waterway across Cape Cod.

New International Encyclopædia, Vols. I to VI inclusive.

National Importance of Cape Cod Canal. Colby M. Chester.

American Sewerage Practice, Vol I. Leonard Metcalf and H. P. Eddy. Gift of the authors.

Library Committee.

NEW ENGINEERING WORK.

(Under this head a brief description of new engineering work contemplated or under construction will be presented each month. Engineers and contractors are requested to send descriptions of their work to the Secretary, 715 Tremont Temple, Boston, before 1st of each month.)

United States Government. — NAVY DEPARTMENT. — *Navy Yard, Boston.* — Work on building a slip for ship construction has been commenced.

Commonwealth of Massachusetts. — METROPOLITAN WATER AND SEWERAGE BOARD. — *Sewerage Works.* — The new screen house at the East Boston Pumping Station is under construction; work under compressed air is being carried on at the siphon at Washington Street, West Roxbury, and the new 60-in. cast-iron relief outfall sewer at Nut Island is being laid.

METROPOLITAN PARK COMMISSION. — The following work is in progress:

Charles River Reservation. — Plans are being prepared for construction of reinforced concrete and stone masonry arch bridge over the Charles River at North Beacon St., Boston and Watertown.

Middlesex Fells Parkway. — Reconstruction of burned portion of Wellington Bridge.

Winthrop Shore Reservation. — Constructing sea wall at northerly end of reservation.

City of Boston. — PUBLIC WORKS DEPARTMENT, HIGHWAY DIVISION, PAVING SERVICE. — Work is in progress on the following streets:

East First St.,	South Boston.	Sea wall.
Seaver St.,	Walnut Ave. to Humboldt Ave.	Grading.
Seaver St.	Humboldt Ave. to Blue Hill Ave.	Grading.
Spring St.,	Gardner St. to Webster St.	Bituminous macadam.

PUBLIC WORKS DEPARTMENT, SEWER AND WATER DIVISION, SEWER SERVICE. — The construction of the Davenport Brook conduit is in progress between Adams and Frederika Sts., Dorchester, where it is 11 ft. by 5 ft. 6 in., and between Carruth and Wessex Sts., where it is 7 ft. 4 in. by 7 ft. 6 in.

At the pipe siphon under the Metropolitan sewer on Washington St., West Roxbury, tunneling under air pressure.

In Beach St., between Atlantic Ave. and South St., 4 ft. by 5 ft. 6 in. concrete sewer is being laid to replace a 4 ft. by 5 ft. wooden sewer.

Work on the Union Park St. Sewage Pumping Station is in progress.

Aberthaw Construction Company. — Quincy, Mass. — For the Fore River Shipbuilding Corp., the Aberthaw Construction Company is building a storage building on which the steel frame is now completed. Brickwork is being started, and the concrete floors are being put in at the same time. The interesting features of this work are the handling of the masonry under cold weather conditions, the building being enclosed by canvas and heated.

The Fore River Shipbuilding Corp., Quincy, Mass., has the following work in progress:

U. S. Battleship *Nevada*.

Eight U. S. submarine boats.

Four torpedo boat destroyers for the U. S. Navy.

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BOSTON SOCIETY OF CIVIL ENGINEERS

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PAPERS AND DISCUSSIONS

THE COMMISSION-MANAGER FORM OF GOVERNMENT AND ITS RELATION TO THE ENGINEERING PROFESSION.

By Henry M. Waite, City Manager of Dayton, Ohio.

(Presented November 18, 1914.)

It gives me great pleasure to be able to try and explain in a brief way some of the points which have come up in the working out of our new charter in Dayton. For cities of Dayton's size, it has been somewhat of an experiment to the public in general and in fact to the minds of a great many people who have advocated this particular form of government. We have avoided going before the public and attempting in any way to advise as to how we have felt, believing that our real duty was to remain on the job and make it a success and then do our talking afterwards. We feel, however, that now, after having had it in operation for nearly eleven months, we can say very candidly that it has so far proved itself as a practicable means of governing cities of at least that size. In looking at it from the point of the engineer, it is somewhat difficult to draw any direct comparison of efficiency until we have completed our figures for the year, and I will therefore briefly go over some of the things, particularly our charter, with a little of the history leading up to

Note. Discussion of this paper is invited, to be received by Edward C. Sherman, Editor, 6 Beacon Street, Boston, before March 15, 1915, for publication in a subsequent member of the Journal.

that charter, and then some of the diversified work it is necessary to do in the running of a city.

We all realize, of course, in the first place, that the more efficient the government the more efficient the employee. Mr. Bryce, in "The American Commonwealth," says, "There is no denying that the government of cities is the one conspicuous failure of the United States." This statement should not be too discouraging because I believe that we have appreciated that fact and have been for years improving our municipal conditions. In 1876 a New York commission was appointed to devise a plan for the government of cities outside of New York, and they suggested the following as the causes of failure of the old forms of municipal government: First, incompetent and unfaithful boards and officers. Second, the introduction of state and national politics into municipal affairs. Third, the assumption by the legislature of the direct control of local affairs. It has been some time since we began to realize that the city was a business corporation rather than an integral part of the state. In 1882, Brooklyn took a step toward concentrated power in connection with concentrated responsibility, by giving the mayor absolute appointive power, without the confirmation of a council, of the principal executive heads of departments. Mr. Woodruff epigrammatically states, "For policy we must elect; for efficiency we must appoint." This has been the difficult step to achieve. It means the breaking down of the political hold upon our municipal affairs, the lessening of the grasp of the professional politician who works for a well-oiled ward and precinct organization first, and efficiency in the municipal organization second. As Mr. Bryce again so aptly states, there is a want of method for fixing public responsibility on the governing persons and bodies. We know from experience that the political appointee's first allegiance is to his political machine. This tradition has shackled general advance. Our advance in municipal affairs, in municipal reforms, has been made, up to the last few years, under the old cumbersome federal form. Personally, I consider that the commission form, and by that I mean the direct commission form, is only a development of the federal form, and not a change, as by it you select

through the ballot specific men for specific functions of government. The results of this, of course, have been partly good and partly bad.

In many instances we have been prone to still further harass and embarrass our municipal officers with laws and red tape, all tending to increase the cost of administration. We can say of American cities what Dante said of his own city, "They are like the sick man who cannot find rest upon his bed, but seeks to ease his pain by turning from side to side." Our failures have been due, primarily, to the form of government, and not entirely to the individuals who administer it.

If you will draw an organization chart of the federal form of municipal government you cannot conscientiously point to the department which is responsible for its failure. I have been somewhat surprised to find the complexity of the municipal organization in Massachusetts. I was in Springfield last night and looked over the organization chart drawn to represent the present Springfield charter. It made the ordinary Chinese laundry check look like thirty cents. But take even an ordinary form of federal government in the middle west where we have but the one board. Just let your minds for a moment draw that chart, which would be first the electorate and then the one body known as the council. It would also extend to the mayor and through each department to the city attorney, the auditor and the treasurer, and then the various functions of the municipal government beneath; following through your chamber or your council, connect up to the mayor, connect up again to the city attorney and the auditor and the treasurer, and you get a complex organization that no man would have in his own business.

It has been our custom always to hold the mayor responsible, yet we have absolutely tied his hands so that he really has no power and no possibility for individuality. You, in your own organizations, would not tolerate it for a minute, and yet we, the electorate, have put this kind of an organization up to our representatives of government and expected them to operate economically and efficiently. What man familiar with business organization and without political ambition would assume the responsibility of running such a municipal organization? With

such an organization and with no power to change it, who would assume the responsibility of running the Pennsylvania Railroad, especially if, in addition to this limitation, he would be given men who must be put into certain jobs and allowed only one party from which to draw those men? To my knowledge, there are instances where city engineers have been told what inspectors to put on a certain piece of work after the contract had been let, and you know the answer. Again Mr. Bryce says, "Many of the mistakes which have marked the progress of American cities have sprung from deceptive conception. The aim was to make a city government where no officer by himself should have power enough to do much harm. The natural result of this was to create a situation where the officer had no power to do much good." In years past, we have laughed at that condition, and it is true that we have tried in every way possible by additional laws to surround our public officials in such a manner that they could not do much harm. That is the confidence that we, as a rule, have had in our public officials.

Municipal efficiency depends upon the divorce of politics from municipal affairs. This has been accomplished in Dayton. The laws of the state of Ohio now allow cities to write their own charters — to enjoy home rule. Dayton accepted the commission-manager form. Five commissioners were elected last November, a year ago, on the short, non-partisan ballot. They were all business men excepting one, who was a laboring man and a typesetter. The commission appointed a city manager, and it is in the manager's power to appoint the five Directors, for the departments of Law, Finance, Welfare, Safety and Service. The Director of Law, who is the city attorney, was on the charter commission and had more to do with the drafting of the charter than any one else. He is familiar with it in every detail. The Director of Finance has been connected with various manufactories in Dayton as treasurer, accountant and purchasing agent, and was a public accountant when appointed. The Finance Department includes the Divisions of Auditor, Treasurer and Purchasing Agent. The Director of Welfare was a minister in charge of a large parish, had studied civic conditions in this country and abroad, and was much interested

in welfare work. He was doing his greatest service to the community outside his church. He has charge of the Divisions of Health, Recreation, Parks, Playgrounds and Amusements, Charities, and all welfare work.

The Commission was unable to recommend anybody in Dayton for the positions of directors of Safety and Service and strongly advised going out of the city for men to fill these two positions. As a consequence, the Director of Service was appointed from out of the city. He is a graduate of the Massachusetts Institute of Technology, has been connected with municipal work in various cities, was on the New York Aqueduct, has been connected with municipal research work, and was my principal assistant in Cincinnati. He has charge of all engineering, the construction, repairing and cleaning of streets and sewers, water-works, collection of garbage and ashes, and the supervision of all public utilities. The duties of the Director of Safety are the charge of the divisions of Police, Fire and Weights and Measures. This position has never been filled, and the city manager is now acting Safety Director, with the prospect that he will be able in time to develop material in either of those divisions suitable for the position of Safety Director, and we are very glad to say that we have been able to do this and that such an appointment will be made the first of the year.

From the above it will be seen that we have been able to select men trained in the particular position which they were called upon to fill. Furthermore, I cannot tell you to-day the political faith or party of any of the commissioners or of any of the directors, or any other appointees.

The commissioners form the legislative body and the manager is directly responsible to them. They are, if you please, a board of directors, and direct the policy of the city government. They meet once a week, passing all ordinances, referring questions which come to them to the city manager for investigation, action or report. Together with the city manager, they form the board of Sinking Fund Trustees, with the Director of Finance as secretary. The directors of the various departments are held responsible for their various departments. They meet

once a week with the city manager, when important questions in each department are taken up and discussed.

Draw a chart of this form of organization and compare it with that of the federal. In our organization chart you have the electorate going direct to the commission, the commission direct to the city manager, the city manager direct to the functions of the government. It is the same organization that you would have in any of your own businesses or in any corporation. In which of these charts is there the greatest possibility for efficiency? In our organization every one knows that the officer's or employee's retention depends upon his results.

By a scientific budget the expenses of every department under the various divisions and subdivisionns are absolutely fixed, and our expenditures are thus limited to actual income. As an example of what that would mean in the governing of a city, we had occasion to make an 8 per cent. cut in all departments this year; as you know, in all municipal work, you first have to estimate your income, and it is necessary of course to make your budget for expenses come inside of your income. There was a falling off in some of our taxes, and we found in the month of July that we would have a decrease in our revenue, below what we had estimated, of about $50 000. By the use of the scientific budget aided by our accounting system (and by this accounting system I can go into the accountant's office to-day and know exactly the balance in every account, and at the end of each month the head of each department receives a financial statement which shows his original allowance in the budget, his expenditures to date, and his unencumbered balance), we were enabled to call in the head of each department and cut down our expenditures $45 000 in two days. The new balances were immediately furnished to each department and their organizations were brought to that new basis. I have attempted that in other cities where they have a fairly good budget but where each department always says, " Cut it off the other fellow."

To give an idea of the various activities which come before a city manager or before the head of any city government, I will run over briefly some of the things which we have done. We have had up with the engineers of the railroads the question

of grade elimination, the plans have been prepared and we went before the people with a referendum bond issue for the city's portion of the elimination of the grade crossings. This was a somewhat peculiar and a very interesting condition, because the people of Dayton absolutely demanded that one of the things which the new form of government must do was to eliminate grade crossings. We proceeded immediately to get the plans prepared and had our estimates of the city's portion of the expense, and at our last election put the question before the people. They voted it down. In other words, the people put the responsibility on the commission. The commission immediately returned the responsibility to the public, and the public refused to pass the bonds. Of course, the peculiar financial condition had everything to do with the failure to pass the bonds, but at the same time the commission got the burden off their shoulders.

Dayton has never had a building code. A board or a commission was appointed, and a code is now being drafted and will be ready the first of the year. Street-car service has been improved, delays have been reduced, some re-routing is under way to give better service.

The curse, of course, of most American cities is their lack of a comprehensive planning system. Each one in his own subdivision will plan as he sees fit to gain the most from his property. We have appointed a planning commission which is now preparing an estimate of what it is necessary to do to proceed on a plan to plat the city three miles outside of its present limits.

The principal idea is that the success of any form of government must ultimately depend upon the people. If the people do not become and stay interested in that particular form of government, it will not be a success; regardless of what the government is, it must in the end go back to the people. So, therefore, the great thing to accomplish is to keep the interest of the people as closely as possible to the government, the government all the time giving the public the benefit of everything it is doing. So various associations were formed to keep the people interested. The Civic Music League was one of them, the idea being to start community music through community centers. It took so rapidly, however, and the people were

so interested in it, particularly the musicians, that they started a series of concerts for this year. The form of these concerts is somewhat unique and interesting. They are giving six concerts in Memorial Hall, which will seat 3 000 people. The first concert was the Paulist choristers, with the complete house sold out at three dollars and fifty cents for the season of six concerts. This is a little less than sixty cents a concert. When you realize that the Civic Music League is bringing here such artists as John McCormack and Alma Gluck, as well as several very fine symphony orchestras, you begin to know what this has meant to Dayton. A three dollar and a half ticket is good for any seat in the house. Two weeks before each event tickets are sent in for reservations. If any preference is expressed, it is fulfilled as nearly as possible. The Civic Music League has sufficient money to meet all expenses in connection with the concerts, with a balance of $1 500. Next year the season tickets will be reduced to three dollars.

A new traffic ordinance has been formed and put into effect. An engineering firm has been engaged to aid us in designing methods of disposing of our garbage and wastes; we are doing the same thing with our sewerage system and our water-works. That is, we engage the best experts that we can get in the country for advisers and are proceeding with our plans on a comprehensive scheme for the future.

We have inaugurated a plan whereby the prosecutor holds an informal court every afternoon, and settles a great many cases outside the police court. Women police have been employed. We have expedited our public work by putting in an arrangement whereby we can borrow money in advance of the assessments, which was never done before, allowing the contractor to be paid as he proceeds. Our water system is somewhat antiquated, being originally planned for a city of 33 000 people. We now have a population of 125 000. You know the result. A great many of the 125 000 cannot be furnished water. In one place there is a drop from 58 lbs. on one side of the river to 25 lbs. on the opposite side.

A great many of our sewers are inadequate. All of these propositions are being worked out now on a comprehensive

scale, to take care of a population which we figure will be 200 000 in 1930. Some of the details of the water-works were somewhat interesting. We found that cards had never been made on the engines, and as soon as we carded them we increased the horse-power 30 per cent. There were other interesting things which we found. An inch and a half steam connection for the first to the second receiver on a triple was found open. Nobody knows how long it had been open. We found in some of the valves that there were unequal lifts, there were unequal springs, and we saved about 50 per cent. There were about 50 per cent. of the springs that obeyed the impulse to lift at the proper time. There were innumerable things of that kind which were found. Our water is obtained from wells and our force pumps are the suction pumps.

We have established a municipal garage.

We increased the budget of the health department about 60 per cent. over that of the previous year, and it is very interesting, while this is far from engineering, it gives an idea of the complexity of the questions that come up. For example, in the city of Dayton we found that there were three distinct nursing activities, two philanthropic and one municipal. They were covering the same territory in some parts of the city by three nurses, and some parts of the city were without any. All of the nurses, both philanthropic and city, were brought together in the Welfare Department and so handled from that department that there is no duplication of effort, with a decreased cost. There was philanthropic effort in playgrounds and gardens associations, and we found that both they and the city were paying for experts. We combined issues, made one large committee, the city appointed part, the Playgrounds and Gardens Association appointed part, and all these efforts were brought together. As a sidelight, we told the citizens that, if they would clean up some of the vacant lots (and you will appreciate that after the flood there were a great many lots covered with rubbish as people cleaned out their yards into the first vacant place they could find), the city would haul off the rubbish and plow the lots, and it was most surprising to find that there were four hundred lots cleaned, four hundred dirty spaces turned into

gardens, four hundred families had fresh vegetables without any cost, and four hundred families had a new interest in life. One garden that I know of particularly was kept by three children, and in addition to supplying themselves and some of their neighbors, they sold seventeen dollars' worth of vegetables from one lot.

Workhouse labor has been employed upon the streets in cleaning and in repairing and also in our public parks.

We have established schools for police and firemen and the fire department has started inspections of buildings. These things are undoubtedly done here in the same way, but they have not always been done in that part of the country.

Our accounting system is exactly the same as you would have in any private business. I doubt if any of you are familiar with ordinary accounting systems in cities. They have been changed and added to a great deal. Every time there was a new function there was a new book opened. It is almost impossible from the books of any of the cities that I have seen to get information which you or anybody else in his own private business would demand, and that is one of the first things we established in Dayton, — a modern bookkeeping system. Particular expenses are kept on unit bases.

We have diagrams which show the deadly parallel, and everybody is ranked on that parallel. There are no political debts to pay. Every man realizes that he stands on his own bottom. With our systems and our diagrams and charts we are able to put the city very close to a business basis.

Our charter requires that the commission employ a public accountant who keeps a running check on our books. You will notice that that is entirely outside of the manager's authority.

I think that I have been able to demonstrate that it is possible to apply business methods to the running of a city and I believe that I have shown that the commission-manager form of government stands for efficiency, publicity and concentrated responsibility. If you don't believe it, I would ask you to assume the duties of a city manager. The city manager is the point where every person puts his finger. We have a complaint station where all complaints come in and are distributed to the

proper departments, with a counter check and a follow-up system. I don't need the follow-up system. They follow me up. We try to keep our office door open all of the time, and as a result ninety per cent. of my time is spent there. This is unfortunate in a great many respects, but it is working itself out, I believe, admirably. I think when the public finds that they can reach you they soon begin to believe they don't need to.

You can appreciate from this form of government that it is absolutely up to the city manager to make good or get out. The charter itself provides for a recall of the city manager. I do not know why that was put in; I don't think it was necessary, as the commissioners are subject to recall, and I hardly think that it is necessary to subject an appointive official to the recall. However, it is in the charter.

As I stated before, the city manager is not hampered by party or pull. It is customary, where I have been, under the old forms, when a new administration comes in, to clean the slate absolutely. I don't know whether that is true here or not, but generally, if the Republican party is in power and the Democrats come in, everybody moves out the first of the year. That is a principle. Imagine running your own business on that basis, — that is, every two years change the entire organization! How long would it be possible to operate a business under such management? When we took hold the first of the year, we told everybody in office he could continue in office, that his retention depended entirely upon his ability and efficiency, with the result that we have found a great many good men, admirable men, who are familiar with the work and are anxious to get ahead. Some of them fell by the wayside, naturally. They have been replaced, with the result that we are building up an efficient organization. As an example, one of the department heads in the treasurer's department was behind in some of his work. I knew nothing of it, it hadn't come to me, but some of the boys in the other departments heard of it. They doubled up from the other departments in that office at night and brought him up to date. I never heard of that before in any other form of government. My experience has been that they usually quit with their pencils in the air about 4 or 5 P.M. I am firmly

of the belief that this particular form of government is the most efficient that has yet been tried, and I think I can repeat my opening statement, that the more efficient the government the the more efficient the employee.

I believe that the position of city manager is an opening with immense possibilities for the engineer. There are now twenty-one cities governed by city managers. It is a natural position for the engineer. The larger problems of American cities of to-day are purely engineering. In smaller cities, the city manager acts in the capacity of city engineer, and in fact acts as the head of all the functions. There is, however, to my mind, gentlemen, a great drawback in getting trained engineers interested in municipal work. They shrink from publicity. And I will say very candidly that if you do, it is a good game to stay out of. You have got to make up your mind, if you do go into this line of work, that you can't carry your feelings on your sleeve. It is a good deal as a man who had been mayor of Cincinnati when I first went there said to me,—" Waite, if you have a sense of humor you will last; if you haven't, they will drive you out of City Hall in two weeks"; and I believe it. They all have all kinds of ideas, and you have to treat them with respect, of course, and you have to let them feel that you are interested in whatever they have. If it is a new scheme for reducing garbage, or whatever it may be, you have to listen to it. An engineer, as a rule, can't stand that kind of a game. Apparently he doesn't want to, he isn't trained that way. He shrinks from publicity, and why? I have tried to reason it out in my own mind and I have come to this conclusion,— I may be wrong, I may be right, but I will give it to you as I have reached it,— that the engineer is given a proposition to work out and he absolutely retires to work out that proposition. I suppose it is fair to say that seventy-five per cent. of the things which engineers work out are never made public, and if they are made public, they are made public by somebody else, some board or some committee. The engineer retires to work out his proposition and then makes his report in writing. I thought for a long time that the trembling and the shaking of my knees when I had to get up before a body of men and make a proposition

was purely personal. But I discovered that it was the result of having carried on all my work alone, without the thought of ever having to go before the public to argue or explain its details, and there are a great many men, engineers, who have that same feeling. I never will forget the first time I had to go before a board of directors and explain a report. I had written to them before but had never had to speak to them. And if you will go back you will find that in your college training the same was true; you wrote everything, you never had to speak. I think a great deal of the fault is due to our education, that the educational institutions do not realize the importance of the engineers' being able to approach the public, and it is a detriment and a handicap to the profession.

It has been quite pleasing to find that a great many colleges are now including municipal courses. We have had in Dayton a great many requests from young men to come and study and work with us with the idea of getting the benefit of that experience. One of the training bureaus in New York asked me how many men we could take, and I told him that we could take care of two, with this understanding, that they would give me one student who was not professional and one who was from an engineering school. To my mind, this particular field is opening to the engineer and I desired to make that comparison between the graduates of the two types of schools. But to our surprise we found that while the academic colleges had scholarships that could be applied to such work, none of the scientific colleges had.

There are, all through the American cities, numerous mechanical, civil and electrical engineers who are doing municipal work. The ordinary engineer will not go into office in a city because he feels that under the old scheme there will be a change about every two years (and good old Massachusetts puts them out sometimes every year), and an engineer will not take that risk. But here is a new field opening up which is creating a position for him which is made for him, if he desires to take advantage of it.

We are being called upon very frequently to recommend somebody as a city manager somewhere, and it is pretty hard to pick the material from men who are drawn in municipal work.

If the engineer desires to get into this opening and take advantage of this new territory which is rightfully his, there is going to be, to my mind, a wonderful field. I think it is the opening of a new field for him, and I believe the beginning of a new era for the government of municipalities.

DISCUSSION.

Questions asked and the answers given by Mr. Waite. Also discussion by Hon. James Logan.

Question: What has been done about flood prevention at Dayton?

Answer, by Mr. Waite: The flood prevention is under a commission — under a flood prevention board, and after considerable study they agreed that the successful plan would be by retention reservoirs. Laws have been drawn and passed by the legislature, and the constitutionality of the bill has been attacked. It has passed into the Court of Appeals and has now gone before the Supreme Court. The engineers are proceeding, however, with their plans for their reservoirs and dams and will have everything ready as soon as the legal end has been disentangled.

Q. What is the function or scope of the Commission?

A. Legislative. It is legislative; it is the policy board, just as a board of directors would be. It designates the policy, passes all legislation, and tells the city manager what he can do. We work together exactly as a board of directors and the president of any large organization.

Q. What are the terms of office of the Commission?

A. Four years. Two are elected every four years, and three every four years — alternate years. The commissioner receiving the largest number of votes is the mayor, who presides over the Commission.

Q. Does it take three times four, or twelve years, to change the policy of the Commission?

A. No. On the first election, two were elected for two years, the two commissioners receiving the least number of votes, so that at the end of two years two more will be elected.

Q. What is your term of office?

A. There is no term of office.

Q. What is the tax rate in Dayton?

A. The tax rate this year was 14.4; next year it is to be 13.6 on a one hundred per cent. valuation.

Q. Do the commissioners receive salaries?

A. Yes, $1 200 a year; and the mayor $1 800.

Q. How much time do they have to devote there?

A. It takes one morning a week, from 9.30 to 12.00, and then of course they go around the city if there is anything of particular importance. Any question of improvement which comes up goes to the Commission, and the Commission refers it to the manager. We investigate and make our report. If it is something of importance, we ask the Commission to go out and look it over.

Q. Do I understand that the heads of the various departments are appointed by the manager?

A. Yes; appointed by the manager, with unofficial approval of the commissioners.

Q. How do you appoint your other subordinates? Are they confirmed by any civil service?

A. Yes. We have civil service. We take them from the list, but it is quite different from the federal form. Under our civil service rules, they put up the entire list. We can select any one from it.

Q. Doesn't that make it rather embarrassing?

A. I don't call that embarrassing.

Q. How do you finance the repaving of the streets? Does that come out of the tax levy?

A. Repairs come out of current revenues and expenses. New improvements come out of assessments. The city bears part.

Q. What part does the city bear?

A. On a street which is being paved for the first time, we assess 98 per cent. The city takes care of the two per cent. and the intersections.

Q. And they stand for it?

A. Yes, sir. We are not spoiled by as much money as you have in this part of the country.

Q. What is the valuation?

A. $165 000 000.

Q. What is the net debt?

A. A little less than six million, $5 763 000.

Q. The city manager is appointed by the Commission. Is he subject to removal by them?

A. Yes, sir. Or by recall of the people.

Q. What method do you use in assessing property?

A. The Board of Assessors.

Q. Is that Board of Assessors appointed?

A. Appointed by the governor of the state.

Q. Then you and your Board of Directors have no power over the assessors?

A. We have no power over the assessing or the tax rate. That is, the assessing is done by the Board of Assessors appointed by the governor, and the tax rate is set by the budget commission. A budget commission is formed for each taxing district. In our district it is comprised of the county auditor, the city attorney, and our mayor. We have two voices against one. That budget commission takes its entire revenue and will first set aside the interest and sinking fund for the debts of the various political divisions, that is, the county, the schools and the city. We have to put our budget before that budget commission and then they apportion what is left to the three divisions. Of course, the state levy is always fixed and has to be met.

Q. How are the expenses of the schools met?

A. The School Board present their budget at the same time that the county and city do, and it is all met out of the one levy.

Q. I understood you to say that the auditor was appointed by the treasurer?

A. By the finance director. There is a finance director who has under him the treasurer, the auditor and the purchasing agent.

Q. Why is the auditor under the same control with the treasurer?

A. I can't see any objection to it, with an outside running check.

Q. How are the expenses of the School Department handled?

A. By the School Board alone.

Q. That is, the School Board is a separate government entirely?

A. We call it a separate political division. We have the four political divisions, the expenses of which have to be met through this budget commission.

Q. Has the mayor any powers outside the Commission?

A. No. He says he is the "speaking member." Of course, the laws of the state require a mayor. The signature of the mayor is necessary on some documents, but he has no more power or authority than the rest of the Commission except he is its presiding officer.

Q. Chairman of the Board of Directors?

A. Not chairman of the Board of Directors, chairman of the Commission.

Q. How are the commissioners nominated?

A. By a petition, two per cent. signers.

Q. Is there any tendency of this form of government to take over the public utilities? Do you think this form of government could run a lighting station, say, as economically as a private company?

A. Of course I will have to say that I think we can, but I hope we won't have to. We have a water-works, and that is enough for the present.

Q. What per cent. of the voting population is necessary for the recall?

A. Twenty-five per cent. of the registered voters.

Q. You spoke of the tax rate. Is that the same on all classes?

A. The same on all classes; there is no classification.

Q. When you selected the first five commissioners, how many were in the running?

A. Fifteen.

Q. You said that the one receiving the highest number of votes becomes mayor. How does that work out on successive elections? I understand that you elected two for two years and three for four years. Is there any change in that?

A. The commissioner receiving the highest number of votes at that election when three are elected, would be the mayor. There is some dispute among themselves whether it is worth the difference in price or not.

Q. How much money are you going to expend on your new water-works?

A. Our plans call for an expenditure of one million in the next two years and two millions in sixteen years.

Q. Can the Commission incur any bonded debt without a referendum of the people?

A. Indebtedness of the city can be 5 per cent. of the duplicate, $2\frac{1}{2}$ per cent. of that the governing body may issue and the other $2\frac{1}{2}$ per cent. has to be issued through a referendum, so in order to avoid using up everything inside of our authority for $2\frac{1}{2}$ per cent. on the large questions we put up for a referendum. Then there are other complications in taxation there. There are two limits of taxation, a ten-mill limit and a fifteen-mill limit. We can't exceed fifteen mills, and out of the ten mills certain expenditures have to be met and the remaining expenditures from the five mills.

Q. What percentage of the voters work for the National Cash Register Company?

A. There seems to be a great deal of jealousy, I find, in Massachusetts, about the National Cash Register Company. I heard in Springfield that the city of Dayton was run by the Cash Register, and I suppose that is your leading remark. I assure you that it is not true.

Our city registration for the state election was 32 000. I find that those proportions here in this part of the country are somewhat startling. In Springfield, last night, I learned that with a population of 100 000 (I think), they have a registration of 16 000. We, with 125 000, have 32 000.

Q. How many voted?

A. Something over thirty-one thousand. The National Cash Register Company employs about five thousand people, a large number of whom are women, and women do not vote in Ohio.

Q. What percentage of the city's yearly income is used in the school department.

A. None of the city's income is used in the schools. The schools this year or next year get about $415 000.

Q. The total taxation is how much?

A. 13.6.

Q. What per cent. is voted for the schools?

A. The schools' proportion out of that 13.6 was 4.16 on $165 000 000.

Q. Was Dayton the first community that had a city manager?

A. No, sir.

Q. How long had the system been in operation before Dayton took it up?

A. Staunton, Va., I think was the first, and they have had it there about four or five years. I think it was in 1908 or 1909. Then Sumter, S. C.

Q. Do you find under the city management that you have decreased the running expenses of the city?

A. Well, I wouldn't put it that way. I will say that we have given them more for their money.

Q. You give them full value for the dollar?

A. Yes.

Q. But you have only been running eleven months?

A. That's all.

Q. Do you see any reasons why that cannot be applied to the larger cities in the country?

A. I can see reasons, yes. I will answer you the way I answered the New York *World*. After I had been in Dayton about forty-eight hours, the *World* wanted to know if I thought it was applicable to a city the size of New York, and I replied, "Yes, if New York is ready to divorce politics from municipal affairs and keep them divorced."

Q. How are the police appointed?

A. By civil service.

Q. By the Commission?

A. By the city manager.

Q. Are there any cities larger than Dayton that have this form of government?

A. No, it is the largest.

Q. Would you be surprised to know that this form of government was sent to two of the leading Boston papers in January, 1908, and refused publication?

A. Was it the Lockport plan?

Q. No, this very plan. Would you be surprsied to know that this plan had been sent to the two leading Boston publications and refused?

A. I am very much surprised.

Q. What has been done with the politicians out there?

A. They are marking time.

PRESIDENT EDDY. — Gentlemen, it is very rarely that the Boston Society of Civil Engineers, and I imagine that it is equally seldom that the Boston members of the American Society of Mechanical Engineers or the Boston Section of the American Institute of Electrical Engineers are honored by having in its audience present or past mayors, and I know you will be interested to know that to-night Mayor Cook of Fitchburg, and very likely during a portion of the evening other mayors with whom I do not happen to be acquainted, were present. I want to trespass on your time just a moment, and I know that you will be well repaid for staying, to present to you a gentleman with whom I have been acquainted for many years. I haven't told him I was going to call on him, but I don't need to. He has had real experience in city work, — Ex-Mayor James Logan, of Worcester, — and has come down here to listen to this address. I know that he is brim full of ideas, and that he really wants to say something.

MR. LOGAN. — I had no thought when I came here of being called on to speak. I came here as a humble learner, and I have learned some things. I have learned that the politicians in Dayton are marking time. And I will suggest that they are only marking time and that we will hear from them later.

It is no easy position to be the mayor or business manager of a city. Being the hired man of 165 000 people like the city of Worcester, for example, is not an easy place, but I want to say to you that, barring newspaper abuse, I never enjoyed a piece of work in my life more than I did this service to the good city of Worcester. I was fortunate in some particulars. I

had no political debts to pay and I had no enemies to punish, and be it said to the credit of Worcester that in the four years that I was in City Hall, no man who was prominent in any of my campaigns ever came to me to ask a favor — not one. And after three months hardly any one else came asking favors. They knew where to find me; courteous I tried to be always, and I never lost my temper but twice in the four years. Once was with the manager of one of the public-service corporations. I did lose my temper then, but it produced the result desired in less than forty-eight hours. After I got through being mayor, my experience had not soured me, and when I rode out on a Sunday afternoon, the cows for five miles round didn't give sour milk.

One asset which I highly prize, that I took back into private life, was the friendships I made in political life. I am thoughtful, and sometimes fearful, for the future of this country when so many men like you here (now, put the coat on, for it fits you) neglect your duties and do not go to both the caucus and the polls. You haven't done your whole duty when you simply go to the polls and vote.

If you don't do your duty, this country has seen its best days. You men, engineers, ought to stand in the community where you are located for the highest and best, and do your part to save it.

Just one little experience before I sit down. I think it was the first month after I became mayor, one of the men in the Board of Aldermen much desired a certain appointment. He said, "You understand, Mr. Mayor, that if that don't go that way I shall object and hold up the appointment." "Well," I said, "that is your privilege and your duty, but it is my business to do the appointing and I won't ask you to assume my responsibility; I will take that myself. Having done my duty as I see it, it will be up to you to do your duty as you see it, and I trust that when we get through we will be just as good friends as before, even though we may not agree in this matter." "Well," he said, "you want to remember that I've got some Scotch blood in me." "Well," I replied, "that may be, and it's good blood, and while we are on that subject, let me say to you that mine is *all* Scotch." And there the matter ended.

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PAPERS AND DISCUSSIONS

DISCUSSION OF THE MECHANICS OF REINFORCED CONCRETE UNDER FLEXURE IN BEAM AND SLAB TYPES.

MR. JOHN R. NICHOLS (*by letter*). — It has been suggested that there ought to be some explanation of the apparent discrepancy between the steel stresses which the application of the principles of statics to a flat slab floor design would lead us to expect and those deduced from extensometer measurements in tests. In the writer's opinion the chief cause of this discrepancy lies in the assumption, commonly involved in the application of statical principles to reinforced concrete structures, that the concrete immediately surrounding the rods is incapable of exerting tensile resistance in a direction parallel to the reinforcement, whereas, in fact, the concrete does act in tension, materially assisting the steel. This opinion is supported by the results of tests on rectangular reinforced concrete beams. For example, Mörsch* presents curves showing that in a beam having 0.4 per cent. reinforcement, a load which, on the assumption of no tension in the concrete, should have caused 16 000 lb. per sq. in. tension in the steel, actually produced less than 3 000 lb. per sq. in., as measured by extensometer. In a beam having 1.0 per cent. of steel, the measured tension was 8 500 lb. per sq. in. for a similar load. The only possible explanation for the low measured stresses in these beams seems to be that the concrete did in fact act in tension.

The following table, computed on the assumption that the

* "Eisenbetonbau," 2d edition (German), p. 101.

concrete acts in tension and follows the same straight-line law of stress distribution in tension that is commonly assumed in compression, gives the tensile stresses in the steel, f_s, and the maximum tension in the concrete, f_t, for loads which, on the assumption of absence of tension in the concrete, would produce a steel stress of 16 000 lb. per sq. in. The depth to the steel is taken as eight ninths of the total depth, as, for instance, in a 9-in. slab, and $\frac{E_s}{E_c}=15$.

TABLE.

p.	f_s.	f_t.
0.001	808	70
0.002	1 530	132
0.003	2 180	189
0.004	2 780	241
0.005	3 330	290
0.006	3 840	335
0.007	4 320	378
0.008	4 750	417
0.009	5 180	455
0.010	5 550	490

Other tests might be cited to support the evidence of the Mörsch tests and the table, to the effect that concrete is capable of assisting the steel through its tensile strength to a marked degree.

The low values given in the table for the maximum tensile stress in the concrete indicate that cracks are not necessarily to be expected in beams and slabs with low percentage of steel and subject to working loads. On the other hand, the tests show that the stress in the steel, as measured by extensometer, remains but a fraction of the stress determined by ordinary computations long after cracks have become visible. It should be pointed out, however, that extensometer measurements do not indicate the stress at any particular point in a rod but only the average over a considerable length, usually eight inches. The stress in a rod at a crack in the concrete may be and probably is much higher than the average over the eight inches of which the crack is the center. Extensometer determinations of the

steel stresses in flat slab floors are, of course, equally subject to error from this source.

On the whole, it seems clear that the low steel stresses reported from flat slab tests, so far as they are not due to inherent defects in the method of their estimate, are chiefly due to tension in the concrete in a direction parallel to the reinforcement.

In order to discuss Mr. Turner's paper with fairness, it is necessary first to attempt to state its main thesis as nearly as may be in clear terms. As the writer views it, Mr. Turner's contention, put into plain language, is as follows:

When tensile reinforcement in concrete consists of two bands of rods at right angles as in a flat slab floor, the concrete interacts between the two bands in such a manner that the tension in each band relieves or reduces the tension in the other.

Mr. Turner supplements this with the assertion, necessary for its validity as a factor in flat slab floor design, that the tension in the concrete incidental to the interaction mentioned is "indirect," and, unlike "direct" tension, is not interfered with in its effectiveness by cracks.

The interaction of the concrete between multiple bands of steel rods in tension is best studied by considering the simple case of two bands, band A and band B, at right angles, both bands equally stressed in tension. Suppose that the unit stress in each band is f_s (pull in each rod divided by the cross-section). Assuming for the moment that the rods are not subject to lateral tension or compression upon their surfaces, the unit strain or extension of the rods is $\frac{f_s}{E_s}$.

The unit tension in the concrete on sections at right angles to the rods let us call f_c. If this tension were acting only in the direction of band A, the unit tension in that direction would be $\frac{f_c}{E_c}$, and, noting that the extension of the concrete is the same as that of the embedded steel, we could then write

$$f_c = f_s \frac{E_c}{E_s}.$$

But in the case we are considering the concrete is subject also to

equal stretching in the direction of band B which induces a lateral contraction in the A direction measured by Poisson's Ratio, R. Then the actual unit extension in the concrete is only $\frac{f_c}{E_c}(1-R)$. Assuming this equal to the unit extension of the steel, we have,

$$f_c = f_s \frac{E_c}{E_s} \cdot \frac{1}{(1-R)}.$$

The effect of multiple way reinforcement in a concrete slab as distinguished from one way reinforcement is thus merely to stiffen the concrete somewhat. For example, if we may take R as 0.1, a commonly accepted value for concrete, and $\frac{E_s}{E_c}$ as 15, we find that in a flat slab $f_c = \frac{f_s}{13.5}$, whereas in a beam we would have $f_c = \frac{f_s}{15}$. The concrete in certain portions of a flat slab floor is thus capable of assisting the steel in tension about 11 per cent. more than the same concrete in a beam or one way slab, — always provided, however, that the concrete does not crack. It is probable that this augmented assistance is actually rendered between cracks, but where cracks occur it would still seem desirable to provide steel enough to take the whole tension without assistance of any kind.

Returning now to the question of lateral stresses in the steel rods, suppose the concrete is able (and willing) to exert on the surface of the rods a lateral tension as high as 500 lb. per sq. in. This would induce a longitudinal contraction equivalent to that produced by a compression of $0.3 \times 500 = 150$ lb. per sq. in., taking Poisson's Ratio for steel at 0.3. Additional longitudinal tension of 150 lb. per sq. in. would then be required to restore the rods to their original extension.

Assuming, now, what is probably untrue and is at best a mere assumption open to grave doubt, that the criterion of failure of the rods is unit extension rather than unit stress, we may safely stress rods embedded in the above "supposed" concrete to 16 150 lb. per sq. in. instead of the 16 000 commonly permitted.

To sum up, the interaction of the concrete between bands of reinforcement which takes place in portions of a flat slab floor renders the concrete some 11 per cent. stiffer than it would be if stretched in one direction only, and perhaps at the same time 11 per cent. stronger. It then gives 11 per cent. more assistance to the steel through its tensile strength, if it does not crack. In addition, perhaps the strength of the steel is increased by something less than one per cent.

It will possibly occur to some that the meager results here extracted from the "interaction of the concrete" are hardly sufficient to explain Mr. Turner's mushroom designs. However that may be, the writer, with all due deference, would like to be shown the process by which more can be extracted.

So far as the writer is aware, Prof. H. T. Eddy is the only person who claims to have justified Mr. Turner's designs of flat slab floors on a theoretical basis. Mr. Eddy's success, however, is due not to consideration of concrete interaction as above set forth, but to his outright assumption that the reinforcement of a flat slab floor is equivalent to a uniform sheet of some kind of homogeneous substance as strong as steel in tension and possessing a Poisson's Ratio of 0.5. He ignores the fact that at least twice the weight of steel in crossed strips or rods is required to provide the same strength in all directions as a homogeneous plate. On the basis of such assumptions almost any design, however inadequate, could be given an apparent justification.

Mr. Turner states in his paper the well-known fact that in a beam with uniform loading the positive bending moment at the center plus half the sum of the negative bending moments at the supports is equal to $\frac{1}{8}WL$. Now, any portion of a flat slab floor for which the outer forces can be determined may be considered and treated as a beam, and if we select the boundaries of such a beam so that the side edges are parallel and free from vertical shearing stresses the load will be uniformly distributed along its length if the floor load is uniform as is usually assumed.

Fig. 1 represents an interior panel of a uniformly loaded flat slab floor of indefinite extent. The portion of the slab

marked out in heavy lines is a beam of which A and B are the sides. These sides are on the center lines of the columns and the vertical shear thereon is evidently zero. C and D are the ends of the uniformly loaded beam the span of which is l_1. The

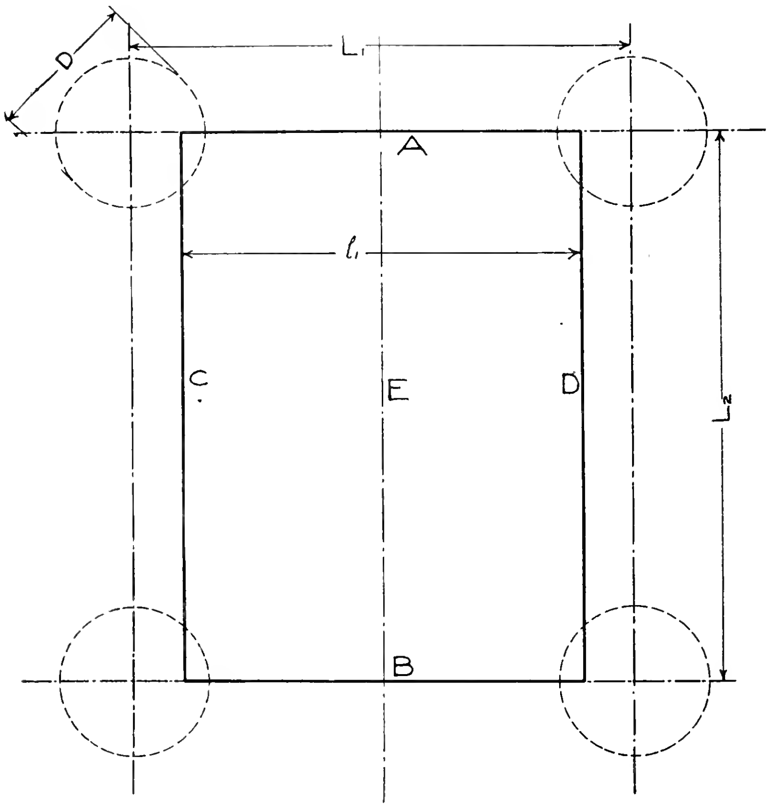

FIG. 1.

writer considers, by the way, that the proper value of l_1 is $L_1 - \frac{2}{3}D$.* We may then write

$$\frac{M_c + M_d}{2} + M_e = \frac{wL_2l_1^2}{8},$$

where w is the total load on the slab per sq. ft. Assuming, as

* Trans. Am. Soc. C. E., Vol. LXXVII, pp. 1670–1673 and 1735.

we ordinarily may for an interior panel, that $M_c = M_d$, we may then write

$$M_c + M_e = \frac{wL_2l_1^2}{8}.$$

There is no escaping the conclusion that, unless tension in the concrete is to be relied upon, steel must be provided in the top of the slab at C and D (of course, mainly near the columns) and in the bottom of the slab at E in sufficient quantity to take care, in the aggregate, of these bending moments, whatever may be the proportion in which any particular designer may wish to distribute it between the three locations. In the case of rods crossing the lines C, D and E at right angles, the full strength is to be considered in determining the moments of resistance, but rods crossing obliquely are to be valued at the components of their allowable strength normal to these lines.

Similarly, steel must also be provided to take care of the positive and negative bending moments of the slab considered as a beam spanning in the direction of the line E.

If steel is not provided to take, at allowable unit stresses, the whole tension incidental to these moments, it is clear that the concrete must assist in direct tension or the steel be overstressed.

DR. HENRY T. EDDY (*by letter*). — The last two or three sentences of Mr. Worcester's letter argue apparently that because it is not clear how the tensile stresses in crossed belts can interact in the matrix of a flat slab in such a manner as mutually to diminish the stress of each belt in the other, no such thing exists. The correct attitude of mind would seem to be to inquire whether the alleged phenomenon exists, and if so, then to attempt to discover its explanation. Now no one would deny that circumferential stresses occur in a thin metal dome and that by their action it is enabled to carry loads far in excess of the sum of the loads which could be supported by all its meridianal segments acting independently, and that these circumferential stresses take up and hold in equilibrium the radial horizontal thrusts induced by the load and acting at right angles to the circumferential stresses. Moreover, they are neutralized at the different levels in the dome where they arise and are not propa-

gated to the bottom of the dome as they are when each segment acts as an independent arch.

Neither will any one conversant with the action of an extended thin plate supported on crossed girders or rows of columns in rectangular array deny that it develops, under load, circumferential tensions about the supports and about the panel centers that enable it to carry much greater loads than the aggregate of all the loads it could support when it resists flexure simply as a beam or as a number of beam strips. If such be the fact, as it is, then no beam strip theory will apply to such a structure or furnish principles for its correct design. In the plate, as in the dome, the circumferential stresses about panel centers prevent the propagation of moments and stresses radially toward the supports by holding the radial stresses in equilibrium, thus making the horizontal stresses in this part of the plate self-contained and thus reducing to a considerable extent the amount of metal which would otherwise be required. A similar action occurs about the supports. The reality and surprising excess of strength and stiffness of a plate over a beam can be very readily demonstrated by a very simple experiment.

Take a sheet of ordinary 8-in. by 11-in. writing paper, which will not support its own weight as a beam between supports 5 in. apart. Lay it upon four equal spools 5 in. apart and place two light strips of wood across the sheet at mid-spans of the spools in the form of a cross. The paper will support a load of several ounces in this manner, thus exhibiting a phenomenon entirely different from beam action, which may be properly designated as plate action. It exceeds beam action many fold.

Now a properly reinforced flat slab imitates plate action sufficiently to take advantage of the same kind of circumferential stresses. It does more than this because it introduces the reinforcement in larger amounts where the stresses are more severe and in less amounts where not needed, thus effecting economy as compared with a uniform plate. That the flat slab does really imitate plate action in the manner just described is the only possible explanation of the results of innumerable load tests of flat slabs in which slab deflections have been observed as well as the results of the few extensometer tests which

have been published. It is only on this basis that any one has attempted to discuss the mechanics of slabs to obtain rational formulas in any accordance with tests.

A circumferential cantilever, as the term is employed in Mr. Turner's paper, is that part of a flat slab over and around a support where actions are called into play by negative bending moments like those developed in a thin metal plate when similarly situated. The difficulty which Mr. Worcester experiences in seeing how it is possible that reinforcement well disseminated through the concrete can cause the slab to act like a plate is due to an insufficient realization of and failure to recognize the important and dominating rôle which the concrete plays in binding the entire fabric of the structure together so reliably that it will act as a unitary monolithic sheet in which radial and circumferential stresses occur much as they would in a homogeneous plate regardless of the directions of the various reinforcing rods in case they are sufficiently disseminated. He would perhaps be willing to admit that for very small loads this might possibly be true, but not for working loads. What we assert is that it still holds up to double the working load, when the elongations of the steel show maximum unit stresses up to 20 000 lb. Under these circumstances the statement does not hold which Mr. Worcester evidently regards as axiomatic, viz., "The total tensile stress cannot exceed the total capacity of the reinforcement," because by the words "total tensile stress" is meant the tensile stress computed on the principle of moments as found in beam structures. It would be just as logical to insist that a metal dome, which is a self-contained structure, must necessarily exert the same horizontal thrust as an arch. Tensile stresses in crossed reinforcing rods coact through the concrete in such a manner that each reduces the intensity of the other, but not in such a manner as is assumed by Mr. Nichols in his calculations. The coaction is by means of the bond shear on the surface of the rods which causes lines of stress in the concrete both of tension and compression in directions at 45 degrees with the rods, and not by direct lateral tension in the concrete in directions perpendicular to the rods. These are two entirely different kinds of actions and have nothing in common,

as will be seen by reference to "Concrete-Steel Construction," Part I,* pp. 121–133. It is well known that the bond in slabs remains intact under loads far beyond tensile loading, and is consequently dependable whether we regard that as due to the indirect tensile stresses at 45 degrees which tie the crossed rods together, or to the indirect compressive stresses by which the crossed rods mutually support each other. However that may be, the reality and dependability of such coaction is unquestionable.

It does not appear that the discrepancy between the statical moments of the applied loads and the moments of resistance of the reinforcing steel can be largely accounted for by considering the tensile resistance of the concrete acting parallel to the reinforcement, as is the opinion expressed by Mr. Nichols. While the facts adduced in support of his opinion are incontestable, they are entirely inadequate to establish the validity of any such explanation of this discrepancy, because the discrepancy still exists at loads so large as to preclude the possibility of any large assistance from concrete in direct tension. The phenomena which are under discussion have reference in general to observations at double the design load with unit stresses in the steel of 16 000 lb., and more where direct tensile stresses in the concrete cease to be of material assistance to the reinforcement. Moreover, it is questionable whether Mr. Nichols' argument respecting the unreliability of extensometer measurement where tension cracks exist in the concrete is valid, because just such measurements as he objects to as unreliable have shown excellent agreement between computed and observed steel stresses in heavily loaded beams.

Mr. Nichols states that "any portion of a flat slab floor for which the outer forces can be determined may be considered and treated as a beam," and he evidently regards it as a self-evident truth. Such, however, it is not, as both theory and test show its incorrectness. Just as well say that a dome may be considered and treated as an arch as to say that a plate or a slab may be treated as a beam. To be sure, it can be done on

* Eddy and Turner, Minneapolis, 1914. This book, the gift of Mr. Turner, may be seen at the library of the Society. — Ed.

paper, and has been done, but of what use is it to do it? No results even approximately correct can be arrived at by the process. The first requirement of applied mechanics is that the assumptions used shall include the predominant phenomena. Beam theory will not do this for slabs. But beam theory is evidently so ingrained in the warp and woof of engineering mathematics that it is perforce used whether it applies or not. It is the old question of whether the world moves or not in a new guise.

It may be observed that in this and other discussions on slabs those engineers who have had occasion to know the facts at first hand by actual test and construction are perfectly aware that there is a wide discrepancy between any deductions from beam theory and floors as actually constructed, and so hesitate somewhat to express definite opinions on theoretical questions at variance with those facts. Many others seem, however, to have no such hesitation.

Mr. Thompson has taken occasion to refer in his discussion of this paper to my recent paper on "Steel Stresses in Flat Slabs,* in which all the available extensometer tests of flat floor slabs, five in number, were compared with the values computed by my formulas, both as to steel stresses and deflections. In a previous paper,† the results of a comparative test of two experimental slabs were given, one of them built on the mushroom type. This last and two of the five preceding slabs were of the mushroom type and the other three of similar design. The stresses and deflections observed at test load showed, as the result of scores of measurements, astonishing agreement between the computed and observed results, as any one can see by examining the papers referred to. At working load, however, there was a single rod showing an abnormal unit stress of 22 400 lb. against a computed maximum stress of 19 500. The reason for this divergence was perfectly well known and clearly stated, but on the basis of this single observation Mr. Thompson asserts that stresses obtained by my formulas did not agree within 50 per cent. with the actual stress, a palpable misstatement which

* Trans. Am. Soc. C. E., Vol. LXXVII, pp. 1338–1453 (1914).

† *Engineering News*, Vol. 69, pp. 624–628, March 27, 1913.

any one who will take the trouble to read the entire discussion referred to will find inexcusable, for Mr. Thompson omits all reference to the extensive additional data from another test which was presented by me in my closure of the discussion to which he refers, which showed conclusively that his contention as to the inapplicability of my formulas was without foundation. Nevertheless he has here repeated his original statement after it has been shown to be without any sufficient foundation. The observed stresses and deflections at test load were in good agreement with computed values.

Mr. Thompson further asserts twice in one sentence that my formulas were based upon the test to destruction of the experimental slab above referred to. There is no foundation whatever for this assertion and it is not in accordance with the facts, as any one will become convinced who will follow their deviation from the general differential equations of plates as given in my books. Not only is the statement incorrect, but it shows that Mr. Thompson does not himself understand how they are established. They are not based on any tests whatever any more than ordinary beam theory is based on tests. The theory is developed, and then since tests show a good agreement with its deductions, the theory is confirmed thereby. The same is true of the slab theory advanced by me. It was applied to the test results of the experimental slab, just as it was to other tests. The remarkable thing about it is that these theoretic formulas which have been compared with numberless other tests should have been found to be in such good agreement with that test also, in which stresses and deflections were observed under a much wider range of loads than usual, and in a slab which was not an integral part of a continuous floor, but under circumstances which Mr. Thompson criticises so adversely. This would seem to be an argument to confirm our confidence in the wide applicability of these formulas rather than otherwise.

Whether Mr. Thompson regards the stresses in the Northwestern Glass Co. slab as excessive or not has nothing whatever to do with the question at issue. The question is this: Do the concordant mathematical theories and formulas developed by Mr. Turner and by myself show a good accordance with experi-

ment, and are they founded on correct mechanical considerations or not?

It is not a fact that there is any material divergence between test results and those computed by us, although Mr. Thompson has attempted to assert otherwise. That question may be safely left to any competent unbiased reader. The other question as to the cogency and correctness of the mechanical considerations adduced as proof of the formulas, is the one open to discussion. Professor Johnson, while he entirely rejects the reasoning proposed in support of them, hazards the opinion that if they are in agreement with test, " they may be in essence merely empirical formulas." Considering the question from the standpoint of the probabilities in the case, it can be said that a single theory which embraces at once both stresses and deflections throughout the slab would have infinite chances against its agreement with a wide range of tests. It might be possible to obtain an empirical formula for deflections and an independent one for stresses when it would be impossible to derive either from the other. On the theory of probabilities it will consequently be necessary to find some other explanation than that given by Professor Johnson.

Mr. C. A. P. Turner (*by letter*).* — The fact that the writer's effort to treat in some detail the mechanics of reinforced concrete under flexure in beam and slab has aroused the interest indicated by this discussion is gratifying indeed. As a designer of structural steel for many years, the writer fully appreciates the enigma presented by reinforced concrete to any member of the profession who has tried to consider its action by the usual mode of reasoning which is adapted to structural steel but not to concrete.

Mr. Worcester's criticism of the writer's effort as a labored one is undoubtedly justified, since the writer's work has been along the line of originating new ideas and putting them to commercial use rather than in presenting them to others in the finished style of a pedagogue.

Since presenting the paper under discussion, the writer's

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* Author's closure.

ideas of the mechanics of bond shear have been elaborated more fully with the assistance of Dr. Eddy in a treatise on the elementary principles of concrete-steel construction,* a copy of which is presented to the Society herewith for the convenience of those who wish to pursue the matter further than the limits of this discussion will permit.

Mr. Martin has answered Mr. Worcester as to the equality of radial and circular stress in the circumferential cantilever with square panels. The mathematical proof will be found in the treatise above mentioned in Chapter IV.

Some ten years ago the writer found it necessary to determine what the deflection of continuous beams and slabs would be under test loads from two to two and one-half times the magnitude of the working load, because building departments and engineers demanded some guarantee of the specific limits of deflections in the work he was designing. In the course of five years of continuous, careful observation of such deflections and tabulation of the results, not only in work designed by himself, but in that designed by others, and on different systems and with no preconceived ideas or theoretical prejudices to warp his judgment, the writer derived the following formula, published by him in 1909:

$$\triangle = \frac{Wl^3}{7\,000\ (1.414)^3\ \Sigma A_s h^2} \qquad (1)$$

for a square continuous panel supported on columns, and

$$\triangle = \frac{Wl^3}{5\,000\ \Sigma A_s h^2} \qquad (2)$$

for the deflection of the continuous beam under test.

In formula (1), l is the diagonal span of the square panel, and in (2), l is the span of the beam center to center of supports respectively; $\triangle$, the deflection; W, the total load; ΣAs, the right cross-section of the steel at mid-span running from support to support; h, the distance from the center of this steel to the top of the slab.

The relation between the two formulas shows that the deflection of the continuous beam is 3.959 times as great as the

* "Concrete-Steel Construction," Eddy and Turner.

deflection of the continuous slab supported on posts, while the theory of work, taking into consideration the difference in the mechanics of the two structures, makes one deflection in round numbers four times the other, an excellent agreement of theory and experiment well within the limits of errors of observation.

The knowledge of the profession at large as to the deflection of concrete floors at the time this five-year investigation was finished may be illustrated by the writer's experience in furnishing the design for the John Deere Plow Company building at Omaha, in 1908. At that time the writer's standard flat slab construction was the only one known commercially, and notwithstanding the fact that he had up to that time erected several scores of buildings and published numerous general articles describing them, the construction was new to the profession. The owners of the building consequently called in Professor Talbot of Illinois to report on the construction. After investigating a number of these buildings, such as the heavy stock house for the Hamm Brewing Company, the great Lindeke Warner building, and others, Professor Talbot was satisfied that such a construction could be put up to carry the loads safely. In his well-known broad-gaged style he made no pretense of being able to compute its strength or deflection, but simply advised the owners to get a bond from Turner for fifty thousand dollars, guaranteeing both its strength and deflection under load. The writer had stated what the deflection would be, and he was asked to guarantee exactly what he figured it to be. The writer furnished the bond, the building was tested, the deflection was in accordance with the guarantee and no injury to the construction was apparent nor any overstress in evidence under a load of double the working load.

In the following year these formulas were given to the public. Since their publication, hundreds of tests have been made which confirm their substantial accuracy.

For the rectangular panel in which L_1 is the long side and L_2 is the short side, (1) reduces to the following approximate formula

$$\triangle = \frac{WL_1^3}{7\,000\,\Sigma A_s h^2} \qquad (3)$$

A general and somewhat more accurate empirical formula may be written covering both the continuous beam and the continuous four-way slab supported on columns either with square panels or with rectangular panels, as follows:

$$\triangle = \frac{Wl^3}{[4\,990 + \sqrt{10^7\,(l - L_1)}]\left(\frac{l}{L_1}\right)^3 \Sigma A_s h^2} \qquad (4)$$

This formula, when $l = L_1$, in other words, when we have parallel reinforcement, reduces to substantially the previous empirical formula (2) for continuous beams. When $L = 1.414\ L_1$, it reduces substantially to formula (1). When L_1 is greater than l and L_1 is less than $1.25\ L_2$, the general formula gives a value substantially the same as (3), but gives deflections increasingly greater as L_1 becomes greater than $1.25\ L_2$. This formula furnishes a convenient method of investigating the effect on the deflection of varying the angle at which bars cross at mid-span. This general formula agrees substantially both with the theory of work and with experimental results, and furnishes a ready means of investigating the effect of the differences in obliquity of the angle of crossing of diagonal belts upon the deflection.

The reason for this marked difference in the relative deflection of rectangular and square panels is made clear by the method employed in arriving at the ratio of four for a square panel as compared with a beam. In the square panel the circular stresses do not affect the vertical geometry of the slab, while in the rectangular panel the circular lines of principal stresses in the square panel become elliptical and those in the direction of the major axis have the marked influence on the vertical geometry of the slab indicated by the formula.

Confusion of the deportment of square panels and rectangular panels and the failure to distinguish between the operation of wide belts coacting by bond shear with the operation of narrow belts which cannot so act accounts for the erroneous views of many of the profession regarding slab action.

In case $l = L_1$, (4) reduces to the continuous beam formula (2) and represents the case of cylindrical curvature, but when

the rods are placed normal to l under this kind of curvature no coaction is possible.

Mr. Worcester is thus in error as to the essential condition of slab action, which is double curvature and not cylindrical curvature. The maximum efficiency occurs when this double curvature approaches spherical curvature. He badly confuses shears and indirect tensions. Horizontal bond shear must remain or act in the direction of the length of the rods, and if acting upon elastic concrete, doubles the efficiency of the rod. Indirect tensions from shear, as Rankine shows, act at 45 degrees to the shearing force and are not parallel to the rod.

Professor Johnson grudgingly admits that some of Turner's structures are satisfactory and that the Turner formula may agree closely with observed deflections and steel stresses, but being founded on experiment (the theory of work not impressing him with favor), they are a kind of rule of thumb production not to be compared from the scientific standpoint with the misapplication of the principles of statics leading to results agreeing with no known experimental evidence, which if the writer correctly understands his position is advocated by him and by Mr. Nichols.

Let us examine the assumed correctness of this reasoning supposed to be based on the inexorable logic of statics. Every known physical and mechanical process in the universe must obey the fundamental law of the conservation of energy. The deflection of a slab under load is a process whose mode of operation consequently conforms to that law. The principles of statics stand upon the *à priori* presumption of the truth of the law of the conservation of energy, and any deductions or applications of those principles apparently at variance with this law are necessarily erroneous and incorrect at some step.

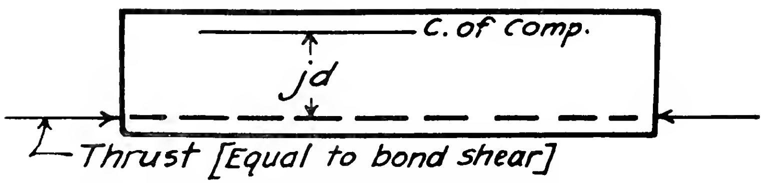
Messrs. Nichols and Johnson would apparently reverse this relation and cast doubt upon the mathematical result worked out by applying the law of conservation of energy under the untenable notion that the law of conservation of energy depends for its validity upon the principles of statics rather than the reverse.

If this fundamental law of mechanics leads to conclusions

contrary to those arrived at by Messrs. Nichols and Johnson by statics and its results harmonize with experimental determinations, it is obvious that while there may be nothing wrong generally with the principles of statics, yet through lack of experience in the application of these principles Messrs. Johnson and Nichols have fallen into serious error.

A fundamental principle of statics cited by Sir Isaac Newton in his "Principia" is that action and reaction must be in equilibrium if there is not to be accelerated motion. Hence in the concrete beam with rods in the bottom the steel stress developed by the total horizontal bond shear is equal to the pull on the rod.

To the extent that the concrete behaves as an elastic material this total shear may, for convenient consideration, be regarded as a thrust applied to the concrete in the line of the rod at the bottom of the beam.



The manner of distribution of this thrust demands attention. Since it produces the same horizontal shearing deformation of the concrete as that caused by the bond shear which for convenience it is supposed to replace, it evidently decreases along this line from the ends of the beam where it is greatest to mid-span where it vanishes. This thrust acts with the lever arm *jd* about the centroid of compression at mid-span, and forms a couple with part of compression acting through the centroid of compression at mid-span to carry part of load on the beam. This thrust it is which prevents the lower part of the beam from elongating to such an extent as to preserve the end right sections of the beam at right angles to the neutral axis after flexure. The pull of the rod is differently distributed from this thrust, being greatest at mid-span and zero at the ends of the beam where the bond shear is greatest and where the equivalent bond shear thrust is assumed to be applied.

Now the total tension in the rods at mid-span is equal in

amount to the thrust just considered because there is no way for the tension at mid-span to have been dissipated and reduced to zero at the ends of the beam except by the bond shears acting on its surface. The arm of the steel tensions is *jd* also, hence the moment of the tension in supporting the load is the same as that of the bond shear so long as the concrete acts as a fully elastic material.

Hence without calling upon direct tensile resistance of the concrete, we see that before the concrete yields in a plastic manner or cracks, the laws of statics require that the steel stress multiplied by *jd* be not greater than half the external moment of the applied load.

Rankine shows that a shear is equivalent to a tension and compression at 45 degrees thereto. Accordingly these indirect stresses of tension and compression respectively form two paths through the web or body of the beam by which the sum of the tensions equals the sum of the compressions above and below the neutral plane respectively.

Now these paths are of equal rigidity during the elastic deformations of the concrete in tension, but as soon as plastic yielding of the concrete occurs, the two paths are no longer of the same rigidity and more and more of the load travels through the path of the indirect compression. But in the mean time the energy stored by indirect tensions is dissipated by the inelastic yielding of the concrete and the static balance of stored potential energy of the internal work of deformation no longer equals the external work of the load and further motion must result until this balance is restored. (See Clapeyron's Theorem, in the work of Lamé on the Mathematical Theory of Elastic Solids, 1866.)

Without going into the molecular physics of the transmission of force through mass it may be well to consider the state of the case where the concrete has cracked at intervals in the tension side of the beam. The indirect tensions tend to rotate the separated segments vertically in a manner furnishing little rigidity and tending to disrupt the beam. The 45-degree compressions, on the other hand, are opposed by compressions from the upper zone arching over and holding them in equilibrium by presenting a relatively rigid resistance.

In this the beam and the slab differ. In the mushroom slab the rotating tendency from bond shear is predominantly lateral rather than vertical with the mass of the slab to oppose such rotation, hence these resistances do not disappear until the final disintegration of the floor structure. This will be apparent from the laws of bond shear stated in the paper and the diagrams of these forces in Chapter III of "Concrete-Steel Construction" by Eddy and Turner.

The issue between Mr. Nichols and the writer may be summarized not as Mr. Nichols has misstated it, but as follows:

Mr. Nichols asserts that the resistance other than that accounted for by the steel must be absorbed by the concrete through a property inherent therein or as a resistance which it possesses previous to embedment and apart from the steel. Turner undertakes to prove that the concrete *per se* possesses no property capable of supplying this resistance until the steel is imbedded therein and bond shear is brought into action as a new element in the load-carrying mechanism.

Turner tries out the question by experiment. Nichols and Johnson are content to believe they possess the intellectual acumen to arrive at correct results by reasoning based on assumption and without recognition of the facts which compel taking account of the evanescent character of the resistance furnished by the assumed direct tensile strength of the concrete, which resistance is known to disappear in the beam under heavy loads but which remains intact and operative in the continuous slab under heavy as well as light loads.

At this point it is well to observe that Mr. Nichols considers that the direct tensile resistance of the concrete in the continuous slab on columns is increased 11 per cent. above its action in beams, and with 11 per cent. increase in effectiveness, he would account for the 300 per cent. increase in stiffness. This would seem to strain the imagination beyond the india rubber limits of its elasticity.

That concrete does have a small value in direct tension is true. This value enables the concrete to shrink in hardening about the steel, thereby furnishing a reliable bond, and this bond supplies, as we have pointed out, the element of resistance that

in a large measure is confused with direct tensile resistance. On the other hand, were the assistance to the steel brought about by direct tensile resistance of the concrete, the concrete must possess tensile resistance several times as great as has ever been discovered by experiment. This fact makes impossible the erroneous explanation offered by Mr. Nichols.

Mr. Nichols cites tests from Mörsch to show that low steel stresses are accompanied by some small direct parallel tensions in the concrete, but he shows utter unconsciousness of the existence of the two dominating and inescapable actions of the embedment which entirely overshadow in their ultimate effect the direct tension to which he refers. These actions are those of bond shear brought about by the shrinkage grip of the concrete on the reinforcement and the casting stresses resulting from the chemical process of hardening. Without the horizontal bond shear, beam action of the reinforcement is an evident impossibility. Hence it is a double absurdity to omit these two principal actions and ascribe their effect to direct stresses which vanish under heavy load.

The hardening of concrete is a chemical process generating heat which expands the steel as the bond is in process of formation. This condition which is followed by the subsequent contraction of the steel induces initial tensile stresses therein of considerable magnitude. These two circumstances largely explain the deportment of newly cast beams under light loads and negative the exaggerated idea of the value of the direct tensile strength of concrete relied upon by Mr. Nichols to substantiate his position. These circumstances further limit the extent of the assistance of the direct tension to ten or fifteen per cent. for light loads and little or nothing for heavy loads. The data furnished by Mr. Nichols are too fragmentary to furnish any basis for determining the amount of the casting stresses, and any sufficient basis for this would require a statement of the temperature at which the cement itself was stored before mixing, the temperature of the water, the temperature of the aggregate and the temperature conditions during the hardening process. Shrinkage stresses may range anywhere from a few hundred pounds to several thousand pounds per square inch

on the steel; every practical builder finds evidence of this in course of the removal of forms at different periods of the year.

This discussion discloses also the practical error made by Mr. Nichols in his assumption that only an unbelievably great and unheard-of direct tensile strength of concrete can possibly account for the experimental evidence cited.

Application of the proposition of Lagrange, known as the principle of least action, with which Messrs. Johnson and Nichols are undoubtedly familiar, would condemn their explanation as erroneous in the light of another and possible one involving lower stresses in the concrete. That this is the case may be readily shown by figuring the intensity of the indirect tensions and compressions as compared with the direct tensile resistance which Mr. Nichols arrives at. The one would be only about 15 per cent. as great as the other.

The impropriety and improbability of supposing as a fact that concrete can exhibit the marvelous property of a uniform modulus of elasticity in tension up to and beyond any known value for its ultimate strength in direct tension is a point in Mr. Nichols' theory which he fails to explain and makes no mention of in advocating its possibility.

The confusion of what the writer actually did say with his own misunderstanding of it accounts for Mr. Nichols' subsequent amusing computation of lateral tension on the rods and Poisson effect of 11 per cent. for the concrete to account for a known increase in stiffness and strength of 300 per cent. over that of a continuous beam.

The writer having explained that the Poisson ratio used by Dr. Eddy is neither a property of the steel nor of the concrete, but merely a useful coefficient of the efficiency of the lateral action of bond shear, Mr. Nichols gratuitously assumes that the Turner analysis by the theory of work based upon the law of conservation of energy is dependent upon assuming such a coefficient. Dr. Eddy used such a coefficient in his method of computation by considering the equilibrium of the infinitesimal elements of the slab, whereas the writer, attacking the problem from the theory of work, does not need such a coefficient, although he arrives at concordant results to those of Eddy and those of experiment.

Mr. Nichols presents a kind of imitation beam formula for the continuous slab, making the moment apparently a function of width rather than length in a rectangular panel, but even with this illogical modification it is impossible to account for the wide difference in action between the beam and slab covered by the writer's empirical equation (4) representing the experimental results.

In process of hardening concrete shrinks about the metal embedded therein and tensile stresses result from this shrinkage, leaving the concrete not only reduced or honeycombed in section by embedment of the steel, but greatly reduced in strength by the shrinkage tensions which furnish bond shear resistance. Accordingly the direct tensile resistance is almost eliminated by the crossing of rods about the column head and to a less extent at mid-span, and this resistance is thus reduced far more nearly to a negligible quantity in the continuous slab than in the continuous beam.

Professor Johnson erroneously refers to the writer's empirical formula for the weakest section with his standard form of construction as applying to the section where the greatest moment is to be supported. The weakest section is determined not by the maximum moment to be borne, but by the maximum unit stress. The practicing engineer would not confuse the two, though it is quite natural for the casual reader not actively engaged in practical construction so to do. The section to which this formula applies is mid-span of the direct belts and a line joining these sections at the diagonal and at the edge of the diagonal reinforcement.

Mr. Thompson would infer that the strength of the Turner floor is exhibited with only one panel loaded. Had he seen a warehouse, designed for 250 lb. per sq. ft., carrying a solid load of sugar fifteen to seventeen sacks high with no aisles, for three months, he would revise his conclusions. The writer naturally protested, but the building had performed the service and the load was to be soon removed.

Mr. Thompson's criticism of the test of the slab to destruction is of interest in view of the fact that it certainly did not have the benefit of continuity, which he says vitiates the test results of a single panel.

Mr. Thompson is somewhat hypercritical and very hard indeed to satisfy. If you test four panels you have made a mistake; it ought to have been one because four panels give a balanced load. If you test one, the results are surely vitiated by continuity. If you saw off the continuity, as in test of a panel to destruction, there is some imaginary objection, such as that you have designed capitals of all sizes and shapes, put them in or left them off, to suit the whim of the architect, and according to the critic a microscopic variation of the cap renders all valid conclusions impossible. Nevertheless, the practical builder puts up all kinds, guarantees their strength, and they give satisfactory service wherever the work is executed with ordinary care. Further, it may be remarked that with all the objections of misapplied statics that have been urged against economical, continuous mushroom flat slab floors, they have never yet been known to tumble down on the heads of the workmen putting them up, even when the workmen have, as has often happened from inexperience, removed the forms from but partially hardened concrete.

That concrete subject to restraint will deform in a plastic manner is well shown in the tests of Woolson cited by Homer Reid, in his "Reinforced Concrete," page 390, and those of Considère as well.

In the beam or slab a considerable degree of restraint is furnished against cracking by the steel embedment, but to assume, as do Messrs. Nichols and Johnson, that concrete when it is being plastically deformed in tension can furnish the resistance to strain per unit of deformation that it does under far lower forces producing true elastic distortion is illogical in the extreme.

The final and most conclusive objection to the explanation by means of the direct tensile resistance of concrete is found in the experience of the builder in nearly or entirely eliminating this direct tensile resistance by a bulkhead or splice in the slab at mid-span. With this bulkhead the deportment of the slab differs only slightly from the slab without the bulkhead.

Perhaps a more exact method of eliminating this direct tensile resistance would be to cast a thin plate of metal properly

coated with paraffine in a small or experimental beam, thus cutting off fully the tensile zone at mid-span. Then the beam without any direct tensile resistances acting with a lever arm *jd* about the centroid of compression would exhibit the marked characteristic of steel stresses too small to balance the external moment of the load. In such an experiment Messrs. Johnson and Nichols will find a complete refutation of their conception of the mechanics of the beam, just as the practical worker in the field of concrete construction has found in thousands of tests a similar refutation by the bulkhead splices used by him in his every-day work.

Concluding my remarks on the utility of direct tension as a dependable element of resistance in bending, I have discussed this more at length from the theoretical and experimental standpoint in the October Proceedings of the Canadian Society of Civil Engineers, in which I discussed tests of concrete slabs to determine the nature and dependability of this element in continuous panels.

Mr. Bryant's frank discussion is of interest. Mr. Martin has answered his somewhat mistaken idea as to the deportment of the standard mushroom design properly executed. Mr. Bryant does find, however, like most skeptics as to the strength manifested by this type, that it is surely present under severe test, and this unexpected finding leaves him with the honest feeling of uncertainty as to his ability to account therefor on any theory hitherto published.

Vol. II FEBRUARY, 1915 No. 2

BOSTON SOCIETY OF CIVIL ENGINEERS
FOUNDED 1848

PROCEEDINGS

NOTICE OF REGULAR MEETING.

A REGULAR meeting of the Boston Society of Civil Engineers will be held on

WEDNESDAY, FEBRUARY 17, 1915,

at 7.45 o'clock P.M., in CHIPMAN HALL, TREMONT TEMPLE, BOSTON.

Mr. William S. Johnson will present a paper entitled, "Ground Water Supplies." The paper will be illustrated with lantern slides.

S. E. TINKHAM, *Secretary*.

PAPERS IN THIS NUMBER.

"The Economic Depth of Trickling Filters," Harrison P. Eddy.
(Presented December 9, 1914.)

"The Depth of Filtering Material and Trickling Filter Efficiency," H. W. Clark.
(Presented December 9, 1914.)

Discussion of "Economic Depth of Trickling Filters."

"Toilet Regulations for Industrial Establishments." Report of Committee.

Current Discussions.

Paper.	Author.	Published.	Discussion Closes.
"Commission-Manager Form of Government.	H. M. Waite.	Jan.	March 15.

ANNUAL MEETING OF THE SOCIETY.

The annual meeting of the Society will be held on Wednesday, March 17, 1915, at the Boston City Club, Ashburton Place, Boston, where the accommodations will be even more satisfactory than those secured in former years at the old clubhouse.

The annual meeting for the transaction of business and the announcement of the result of the letter-ballot for officers will be held at 12 o'clock noon. A short address will be made by the retiring president.

The annual dinner will be served at two o'clock, in the banquet hall of the club.

In the evening a smoker will be held in the banquet hall, at which light refreshments, music and other entertaining features may be expected.

Further details will be furnished in a special circular to be sent out early next month and in the March Journal.

ANNUAL MEETING OF THE SANITARY SECTION.

The annual meeting of the Sanitary Section will be held Wednesday evening, March 3, 1915, at the Boston City Club.

Dinner will be served at 6.00 o'clock in one of the special dining rooms. It is expected that the new building will be available for this meeting.

The business meeting will begin at 7.30 o'clock. The business includes the following: Minutes of previous meetings,

reports of committees and election of officers for the ensuing year.

The speaker of the evening will be Mr. David A. Hartwell, Chief Engineer of the Sewage Disposal Commission, Fitchburg, Mass., who will present a paper on "The Fitchburg Sewage Disposal Works." The paper will be illustrated by lantern slides.

Make it a point to attend the annual meeting and enjoy a social evening.

Frank A. Marston, *Clerk.*

MINUTES OF MEETINGS.

Boston, January 13, 1915.—A special meeting of the Boston Society of Civil Engineers was held this evening in the Society Rooms, at 8 o'clock, Vice-President Richard A. Hale in the chair. There were 36 members and visitors present.

Mr. Sanford E. Thompson read in part a paper prepared by him and Mr. William O. Lichtner, on "Construction Management." This paper was read at a meeting of the Western Society of Engineers held in Chicago on December 21, 1914, and by permission of that Society it is presented at this meeting for discussion.

The following, among others, took part in the discussion: Sanford E. Thompson, William O. Lichtner, J. Arthur Garrod and Leslie H. Allen. These discussions will be printed with the original paper in the *Journal of the Western Society of Engineers.*

Adjourned.

S. E. Tinkham, *Secretary.*

Boston, January 27, 1915.—A regular meeting of the Boston Society of Civil Engineers was held this evening at Chipman Hall, Tremont Temple, and was called to order at 8 o'clock by the senior Vice-President, Charles R. Gow. There were present 90 members and visitors.

By vote, the reading of the record of the last meeting was

dispensed with and it was approved as printed in the January JOURNAL.

The Secretary reported for the Board of Government that it had elected the following to membership in the grades named:

Members: Frederick Thornton Alden, Lloyd Elliot Baker, Roderick Stuart Barnes, Arthur Eliot Blackmer, Walter Keith Brownell, Byron Chapman Bussey, Joseph Lewis Carr, Martin Charles Cherry, Charles Francis Dingman, Henry Francis Dolliver, John Henry Duffy, Clyde M. Durgin, Charles Leavitt Edgar, Robert Benneson Farwell, Louis Ernst Flett, Philip Ely Fuller, John Patrick Gallagher, John M. Goodell, Thomas F. Gray, John Henry Griffin, Jesse Franklin Hakes, James Hayes, Jr., Charles Irwin Hosmer, Howard Chapin Ives, Charles D. Kirkpatrick, Arthur J. Knight, Harry Eleazer Lake, Alfred Rainford Mellor, Charles Augustus Miller, James Andrew O'Brien, Eugene Stewart Patton, Lew Knowlton Perley, Chauncey Rusch Perry, Frank Linwood Preble, Fred W. Proctor, John W. Raymond, Jr., Fred Burgess Skillin, George Carter Stone, Joseph Andrew Tosi, Winthrop Lodge Wales and Robert J. H. Worcester.

Associates: Walter T. Hoover and George Edwin Stuart.

Juniors: William Augustine Brown, William J. Cochran, Marshall Bertrand Dalton, Harold F. Davis, Robert Elwyn De Merritt, Walter C. Eberhard, Harrison Prescott Eddy, Jr., Victor Joseph Gallene, Raymond Daniel Gladding, John Baxter Hanna, Arthur William Knowlton, Millard Bartlett Pinkham, George Washington Simons, Jr., Stanley Armstrong Smith, Howard Cushing Thomas and Christian Frederick Wolfe.

On motion of Mr. George A. Carpenter, it was voted that the Chair be requested to appoint a committee of three to suggest to the meeting the names of five members to serve as a committee to nominate officers for the ensuing year. The Chair appointed, as that committee, Messrs. George A. Carpenter, William S. Johnson and Ralph E. Curtis. Later in the meeting the committee reported the following names as members of the nominating committee, and by vote they were elected: Messrs. Arthur T. Safford, Frederic I. Winslow, Irving E. Moultrop, Arthur L. Plimpton and Bertram Brewer.

The Secretary presented memoirs of deceased members prepared by committees of the Society as follows:

Memoir of Past President George B. Francis; committee, John W. Ellis and Edwin J. Beugler; Memoir of Lucian A. Taylor; committee, William E. McClintock and Frank E. Hall; and Memoir of Albert H. Howland; committee, Frederick Brooks and Frank L. Fuller. By vote, the Memoirs were accepted and ordered to be printed in the JOURNAL.

The chairman then introduced Mr. Nathan H. Daniels, a member of the American Institute of Electrical Engineers, who read a paper entitled, "Insurance as an Aid to Engineers." The paper was illustrated by lantern slides. A discussion followed the reading of the paper, in which Prof. Frank B. Sanborn, Mr. Daniels and others took part.

After passing a vote of thanks to Mr. Daniels for his interesting and valuable paper, the meeting adjourned.

S. E. TINKHAM, *Secretary.*

APPLICATIONS FOR MEMBERSHIP.

[February 6, 1915.]

THE By-Laws provide that the Board of Government shall consider applications for membership with reference to the eligibility of each candidate for admission and shall determine the proper grade of membership to which he is entitled.

The Board must depend largely upon the members of the Society for the information which will enable it to arrive at a just conclusion. Every member is therefore urged to communicate promptly any facts in relation to the personal character or professional reputation and experience of the candidates which will assist the Board in its consideration. Communications relating to applicants are considered by the Board as strictly confidential.

The fact that applicants give the names of certain members as reference does not necessarily mean that such members endorse the candidate.

The Board of Government will not consider applications until the expiration of twenty (20) days from the date given.

McNulty, Richard James, Boston, Mass. (Age 45, b. Dorchester, Mass.) Educated in Boston public schools. From 1888 to 1892, draftsman with Edward A. Buss, mill engineer, on mechanical and mill design; from 1892 to 1894, draftsman with the Boston Board of Survey and mill architect and engineer for several companies; from 1894 to 1896, with Percy N. Kenway and Prof. S. Homer Woodbridge, on heating and ventilating work; from 1896 to 1904, with the Metropolitan Sewerage Commission on general work including pumping station and machinery design; from 1904 to date, with the Boston Sewer Division on architectural, mechanical and sewer work. Refers to E. A. Buss, C. H. Dodd, E. S. Dorr and W. T. Wiley.

Smulski, Edward, Brookline, Mass. (Age 31, b. Pacykow, Austrian Poland.) Graduate of Imperial and Royal Polytechnic Inst., Lemberg, Austrian Poland, 1907. During year 1903–4 (fifteen months) draftsman and estimator with Bureau of Highways and River Improvements, Austrian Government; worked during vacations with M. of W. Dept., Austrian Government Railroads; from Nov., 1907, to April, 1910, with Sanford E. Thompson, cons. engr., as assistant engr.; from April to Aug., 1910, designer with Corrugated Bar Co., St. Louis; from Aug., 1910, to March, 1911, with Ralph Modjeski, civil engineer, Chicago, Ill., chiefly on bridge design; from April, 1911, to Sept., 1912, assistant bridge engineer, Louisville & Nashville R. R.; from Sept., 1912, to date, designing engineer with S. E. Thompson. Refers to R. D. Bradbury, B. S. Brown, S. E. Thompson and J. R. Worcester.

LIST OF MEMBERS.

ADDITIONS.

Atwater, Ralph W. . . . . 1 Avon St., Somerville, Mass.
Balsor, Frederick N. . . . . 1176 Cambridge St., Cambridge, Mass.
Barnes, Roderick S. . . . . 18 Federal Bldg., Albany, N. Y.
Blackmer, Arthur E. . . . . Town Engineer, Plymouth, Mass.
Bussey, Byron C. . . . . 11 Star St., Pawtucket, R. I.
Curtis, Allen . . . . 132 Centennial Ave., Gloucester, Mass.
Gallagher, John P. . . . . 3 Green St., Watertown, Mass.
Goodell, John M. . . . . 34 May St., Worcester, Mass.
Kimball, Herbert S. 111 Devonshire St., Boston, Mass.
Hosmer, Charles I. 54 High St., Turners Falls, Mass.
Lake, Harry E. . . . . 1307 Commonwealth Ave., Allston, Mass.
Mellor, Alfred R.,
care Mass. Harbor & Land Comm., State House, Boston, Mass.
Rand, Robert . . . . 220 Devonshire St., Boston, Mass.
Sears, Walton H. . . . . 60 Federal St., Boston, Mass.
Simons, George W., Jr. . . . . 63 Astor St., Boston, Mass.
Starr, John A. . . . . 148 Irving St., Watertown, Mass.

Stearns, Ralph H.	1 Ashburton Place, Boston, Mass.
Stone, George C.	60 Federal St., Boston, Mass.
Wolfe, Christian F.	214 West Canton St., Boston, Mass.
Wood, Carl W.	39 Greenleaf St., Malden, Mass.

CHANGES IN ADDRESS.

Ackerman, A. S.	11 Francis St., Newport, R. I.
Barnes, Rowland H.	93 Federal St., Boston, Mass.
Carpenter, George A.	55 High St., Pawtucket, R. I.
Durham, H. W.	34 Gramercy Park, New York
Fielding, William J.	225 Ashmont St., Dorchester, Mass.
Murphy, Edward T.	7 Hancock St., Boston, Mass.
Norwood, Leon O.	Resident Engineer, Union, Me.
Peters, Anthony W.	53 Lincoln St., Boston, Mass.
Rich, Malcolm	440 South Station, Boston, Mass.
Shailer, Robert A.	41st St. and Park Ave., New York
Shedd, George G.	290 Lexington St., Waltham, Mass.
Thorpe, George H., Jr.	Columbia Ave., Millville, N. J.
Waldstein, Julius	21 Temple St., Boston, Mass.

EMPLOYMENT BUREAU.

The Board of Government maintains an employment bureau for the Society, to be a medium for securing positions for its members and applicants for membership, and also for furnishing employees to members and others desiring men capable of filling responsible positions.

At the Society room two lists are kept on file, one of *positions available* and the other of *men available*, giving in each case detailed information in relation thereto.

Men Available.

284. Age 23. Graduate of Mechanic Arts High School, 1908; student in civil engineering course, International Correspondence School. Has had six years' experience with Aspinwall & Lincoln, Boston, as rodman, transitman and, for about two years past, as surveyor; has thorough knowledge of calculation. Desires position as transitman or surveyer. Salary desired, $15 per week.

285. Age 32. Graduate of Univ. of Maine, 1904. Has had over ten years' experience, mostly on construction work, including three years as resident engineer on hydro-electric construction, two years as resident

engineer on irrigation work and three years on municipal work. Desires position along any of these lines. Salary desired, $125 per month.

286. Age 27. Graduate of Sheffield Scientific School, Yale Univ., electrical engineering course. Has had three months' experience in repairing shop of electrical department of Conn. Co., working mostly on motors, controllers, wiring of cars, lights, etc.; with General Electric Co., West Lynn, for short time in engineering course. Will accept any kind of electrical work in power station. Salary desired, $15 per week.

287. Age 38. Graduate of Mass. Inst. of Technology, 1899. Experience includes about one year as rodman and instrumentman with Brookline Engineering Dept.; about ten years as draftsman, office assistant and assistant engineer with Metropolitan Sewerage Works; three years as assistant engineer in charge of business office and drafting-room at main office of Boston Elevated Ry. Co.; one year of private practice, surveying, plotting and drafting; one year inspecting construction of sewers, drains and streets for Brookline Engineering Dept. Desires position in office or on drafting room work, especially one affording experience in reinforced concrete design with engineer or contractor in or near Boston. Salary desired depends upon nature of work.

288. Age 30. Graduate of Toronto Univ. in mechanical and electrical engineering. Has had four years' experience with B. & A. R. R., on drafting and outside construction of track layout and docks; three years with Stone & Webster Engrg. Corp'n, on drafting and designing. Desires work in mechanical, electrical or general drafting and design. Salary desired, $25 per week.

289. Age 29. Received degree of A.B. from Middlebury College, Vt., in 1908. Has had five years' experience as land surveyor and has done some drafting; also worked short time as rodman, chainman and transitman with civil engineer in Clinton, Mass. Desires position as transitman, rodman, draftsman or as general helper in an engineering office. Salary desired, from $12 to $18 per week.

LIBRARY NOTES.

Recent Additions to the Library.

U. S. Government Reports.

Analyses of Mine and Car Samples of Coal Collected in Fiscal Years 1911 to 1913. Arno C. Fieldner and others.

Annual Report of Director of Bureau of Mines for 1913–14.

Geology and Oil Prospects in Waltham, Priest, Bitterwater and Peachtree Valleys, California. Robert W. Pack and Walter A. English.

Gold and Silver in 1913. H. D. McCaskey.

Gold, Silver, Copper, Lead and Zinc in Idaho and Washington in 1913. C. N. Gerry.

Gold, Silver, Copper, Lead and Zinc in Nevada in 1913. V. C. Heikes.

Some Deposits of Mica in United States. Douglas B. Sterrett.

Mineral Products of United States in 1912 and 1913. Edward W. Parker.

Production of Natural Gas in 1913. B. Hill.

Production of Petroleum in 1913. David T. Day.

Sampling and Analysis of Coal. Arno C. Fieldner.

Source, Manufacture and Use of Lime. Ernest F. Buchard and Warren E. Emley.

Results of Spirit Leveling in Virginia, 1900 to 1913, inclusive. R. B. Marshall.

Stone Industry in United States in 1913. Ernest F. Burchard.

Water-Supply Papers 326, 329, 345-G, 347, 366.

State Reports.

Maine. Report of State Board of Health for 1912 and 1913.

Massachusetts. Acts and Resolves of Legislature, Session of 1914.

Municipal Reports.

Baltimore, Md. Annual Report of Water Board for 1913.

Chicago, Ill. Report on Industrial Wastes from Stock Yards and Packingtown, 1914.

Providence, R. I. Annual Report of Public Works Department for 1914.

Miscellaneous.

American Sewerage Practice, Vol. II. Leonard Metcalf and Harrison P. Eddy. Gift of the authors.

American Society for Testing Materials. Proceedings for 1914, Part II. Gift of L. C. Wason.

Architekten-Fund Ingenieur-Verein zu Hamburg: Hamburg und seine Bauten, 2 vols. Gift of Desmond FitzGerald.

Boston Water Works: Clippings, 1885–1893. Gift of Desmond FitzGerald.

Capital. George L. Walker.

(The) General Education Board: Account of Its Activities, 1902–1914.

Notes on Catenary Construction of New York, Westchester and Boston Railway. Sidney Withington.

Universal Safety Standards. Carl M. Hansen.

LIBRARY COMMITTEE.

BOOK REVIEWS.

AMERICAN SEWERAGE PRACTICE, VOLUME I, DESIGN OF SEWERS, by Leonard Metcalf and Harrison P. Eddy; published by McGraw-Hill Book Co., Inc., New York, 1914. Cloth, 6 in. by 9 in., 747 pages, 328 illustrations, 172 tables. $5.00.

Reviewed by Frederic P. Stearns.

The volume on the " Design of Sewers " is the first of three volumes intended to cover the whole field of American sewerage practice, and, as would be expected from the high standing and large experience of the authors in connection with sewerage work of all kinds, is a thoroughly practical book for the use of engineers engaged upon such work.

Too often books for engineers are written by those who have not had sufficient practical experience to enable them either to supply much original information or to use good judgment in compiling the results of the experience of others. This book, by contrast, shows throughout that the authors thoroughly understand their subject, that they are able as the result of their extended practice to furnish much original material, and that they have used good judgment in selecting from the practice

and experiments of others an immense amount of valuable material which has heretofore been scattered through engineering journals, reports and society publications.

One cannot fail to be impressed with the great amount of work involved in the preparation of the book, and readily accepts the statement in the preface that " the preparation of this book has demanded an amount of time and effort far in excess of that anticipated when the work was undertaken."

It is impracticable in a brief review to mention even the subjects of the many chapters, and if this were done they would not by themselves give an adequate idea of the breadth of treatment. All incidental questions which are likely to arise in designing sewers are discussed, and in addition many features are introduced to make it easier for the engineer in charge of a sewerage system to obtain records which will assist the sewer designers of the future.

For instance, in the chapter headed "Precipitation," all kinds of automatic rain gages are discussed and illustrated, and samples of the automatic records made by the gages are given. There is a short discussion of clock movements and of the setting and exposure of gages; then many diagrams are presented showing the intensity of precipitation during heavy rains of varying lengths in all parts of the United States, and in conclusion the subject of the frequency of heavy storms is discussed.

The hydraulics of sewers are very fully treated in all branches, including many allied features such as minimum grades and the transporting power of water. Many diagrams are provided to facilitate computations.

The chapters relating to the design of sewers and their many appurtenances have especial value, as the authors, by their researches and through the coöperation of other engineers, have obtained and illustrated a great number of examples of modern practice. This gives the engineer quick access to the designs of sewers and appurtenances which he could otherwise obtain only through a long search of reports and other engineering literature, and to many others which have never been published.

It is of interest to note that the authors in their preface acknowledge the cordial assistance of many other engineers and authors, and later state that "the book is at least a monument to coöperative effort and good-will among civil engineers." In the introductory chapter they refer to the wonderfully rapid progress in sewerage and sewage disposal in recent years, and state that the reason for this "will be found in that admirable spirit of good-will and coöperation existing among American engineers."

The book is a generous contribution by the authors to the progress of sewerage engineering, as its general purchase by those interested in sewerage engineering obviously cannot compensate in a monetary way for the immense amount of labor and expense involved in its preparation.

Universal Safety Standards, by Carl M. Hansen, M.E. "A Reference Book of Rules, Drawings, Tables, Formulæ, Data and Suggestions for the Use of Architects, Engineers, Superintendents, Foremen, Inspectors, Mechanics and Students." Compiled under the direction of and approved by the Workmen's Service Bureau, New York.

Reviewed by Edward F. Miller.

The author has divided the subject into four general groupings: I. General Safety Standards. II. The Machine Shop. III. The Foundry. IV. Rules for Practice.

Under General Safety Standards, such items as fire protection, design of stairs, safeguarding elevator openings and hatchways, safety devices for locking elevators, means for preventing overspeeding of engines, guards for power generating and power transmitting apparatus, boiler and main stop valves, care of dangerous gases, vapors, etc., have been treated.

Part II takes up in detail the methods of protecting the operation of machine tools and of the allied equipment in general use in large machine shops.

Part III treats with the same detail the protection of men working in a foundry.

Part IV in concise, clear wording gives in seven pages

" Rules " for use of an operative in safeguarding himself from accident.

Parts I, II, III contain 206 pages of cuts illustrating the various devices which may be used in protecting the operatives.

This book through its illustrations will be found helpful to the owner of a shop or factory where there is machinery to be safeguarded, as well as to the engineers who may be installing machinery.

After looking at the elaborate systems of guarding to be seen on some of the cuts of machine tools one wonders why the makers of these tools have not before this considered the protection of the operative.

NEW ENGINEERING WORK.

(Under this head a brief description of new engineering work contemplated or under construction will be presented each month. Engineers and contractors are requested to send descriptions of their work to the Secretary, 715 Tremont Temple, Boston, before 1st of each month.)

United States Government. — Navy Department. — *Navy Yard, Boston.* — A slip for ship construction is being built.

Commonwealth of Massachusetts. — Metropolitan Water and Sewerage Board. — *Water Works.* — The tunnel and pipe line under Chelsea Creek, about 800 ft. above Meridian St. bridge, has been completed and is now in service. Work is in progress on the removal of the two 24-in. submerged pipe lines formerly used.

Sewerage Works. — The new screen house at the East Boston Pumping Station is the only work now under construction.

Metropolitan Park Commission. — The following work is in progress:

Charles River Reservation. — Plans are being prepared for construction of reinforced concrete and stone masonry arch bridge over the Charles River at North Beacon St., Boston and Watertown.

Middlesex Fells Parkway. — Reconstruction of burned portion of Wellington Bridge.

Winthrop Shore Reservation. — Constructing sea wall at northerly end of reservation.

Boston Transit Commission. — *Dorchester Tunnel.* — The Dorchester Tunnel is substantially completed from Tremont St. to the westerly side of Dewey Square, with the exception of the interior finish in the Washington station, which extends from Washington to Chauncy St. The work of finishing the station is nearing completion.

Section D includes a station under Dewey Square and about 450 ft. of tunnel under Summer St. east of the station. Work is now in progress on both station and tunnel. The Hugh Nawn Contracting Co. is the contractor.

Section E includes two single-track circular tunnels which will extend from near the junction of Summer St. and Dorchester Ave. under Fort Point Channel and private property to a point near Dorchester Ave. between West First and West Second Sts., South Boston. These tunnels will be driven by means of shields and with compressed air. Work has begun on the main shaft in West First St. P. McGovern & Co. are the contractors.

Enlargement of Park Street Station. — A brief description of the work for the enlargement of Park St. Station was given in the December issue of this Journal. The work is now nearly completed. There yet remains to be done the work of lowering parts of the platforms of the old station, the completion of the interior finish on the walls and ceiling of the enlargement, and a few minor details. Coleman Bros. are the contractors for building the enlargement.

East Boston Tunnel Extension. — Northwesterly of Cornhill, extending to North Russell St., the tunnel has been completed with the exception of the station finish, stairways, entrances and exits. In Court St., between Franklin Ave. and Cornhill, the sidewalls of the tunnel have mostly been built. The invert of the East Boston Tunnel is being removed and the earth underneath excavated to the new grade. The steel

columns and beams are being set to support the old roof which is to remain in place.

City of Boston. — PUBLIC WORKS DEPARTMENT, HIGHWAY DIVISION, PAVING SERVICE. — Work is in progress on the following streets:

Spring Street, between Gardner and Webster streets, excavating and grading.
Temple Street, between Spring to Ivory streets, excavating and grading.
Deering Road, between Blue Hill Avenue to Harvard Street, excavating and grading.
Seaver Street, between Walnut and Humboldt avenues, excavating and grading.
East First Street, sea wall.

PUBLIC WORKS DEPARTMENT, SEWER AND WATER DIVISION, SEWER SERVICE. — The following work is in progress:

Union Park Street Pumping Station, South End. — Installing suction and discharge pipes.

Beach Street at Lincoln Street, City Proper. — Reinforced concrete sewer replacing old wooden sewer.

Milton Street, Hyde Park. — Ejector station, ready to be tested January 27.

Davenport Brook Conduit. — Dorchester; in progress.

DIRECTORS OF THE PORT OF BOSTON. — *Bulkheads.* — Work is in progress under this contract and the work is now about 95 per cent. completed.

Dredging. — The dredging of the Reserved Channel in South Boston easterly from the L Street bridge is in progress under two contracts, making a channel with 30 ft. of water at mean low water and a width of 300 ft. The suction dredge *Tampa* is discharging filling into the bulkhead on the south side of the dry dock site.

Designing. — Studies are being made for the comprehensive development of the port.

New York, New Haven & Hartford Railroad. — CLINTON, MASS. — *Elimination of Grade Crossings.* — New passenger station has been put into service, practically completing the elimination of grade crossings.

The Fore River Shipbuilding Co., Quincy, Mass., has the following work in progress:

U. S. Battleship *Nevada.*

Eight U. S. submarine boats.

U. S. Torpedo Boat Destroyers *Cushing*, *Tucker* and *Nos. 63* and *64.*

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PAPERS AND DISCUSSIONS

THE ECONOMIC DEPTH OF TRICKLING FILTERS.

By Harrison P. Eddy, President, Boston Society of Civil Engineers.

(Presented before the Sanitary Section, December 9, 1914.)

In a paper entitled "Economics of Sewage Filters," presented to the recent convention of the American Society of Municipal Improvements by George W. Fuller, M.Am.Soc.C.E., the author presents certain theories and computations relating to the economic depth of trickling filters. He concludes with the following statement: "Taking everything into account, the writer believes that a sprinkling filter bed of not less than 6 ft. and not more than 7 ft. will, in a great number of cases, prove the most economical to use."

Mr. Fuller's paper is interesting as it touches upon one of the problems which has caused much perplexity in the minds of engineers designing sewage treatment plants. In connection with the design of the trickling filters for the city of Fitchburg, Mass., the writer made a study of the results obtained by the operation of various experimental and practical trickling filters. At the conclusion of this study, the evidence seemed to point more strongly toward the confirmation of the conclusions of the Royal Commission to the effect that the capacity of trickling

Note. A discussion of this paper is printed elsewhere in this number of the Journal. Further discussion is invited, to be received by Edward C. Sherman, Editor, 6 Beacon Street, Boston, before April 15, 1915, for publication in a subsequent number.

filters is substantially proportional to their cubic contents, regardless of depth, rather than toward those of Mr. Fuller.

It is quite remarkable that, of all of the experimental filters which have been operated in this country, there seems to have been no group of filters of equal areas and different depths which have been operated by applying the greatest quantities of sewage which could be treated and produce effluents of practically uniform quality.

A majority have been operated to show the effect upon the degree of purification of the depth of stone with the same quantity of sewage per unit of surface area instead of per unit of volume of filtering medium. It is very hard to draw reliable conclusions as to the economic depth of filters from varying degrees of purification obtained by means of filters of various depths. On the other hand, the relative merits of the deep filter over those of the shallow filter could have been determined readily if the filters had been dosed with the quantities of sewage per cubic yard of filtering material which would have produced effluents of substantially equal quality.

However, it is possible to select certain of the trickling filters, the results of the operation of which can be compared with some accuracy, to throw light upon this question.

Under ordinary conditions the load upon the filter can perhaps be most readily determined if computed in terms of grams of nitrogen per cubic yard of filtering material. These figures can be converted into number of persons served per cubic yard of material by assuming a given quantity of nitrogen per person as 15 grams per capita of unoxidized nitrogen, including free ammonia and total organic nitrogen. Such a comparison of the operating results of a number of trickling filters can be made from data given in Table 1.

The Gloversville experiments given in this table indicate that the 10-ft. filter, although treating a greater quantity of nitrogen per cubic yard, produced nearly as good an effluent as the 7-ft. filter and a better effluent than the 5-ft. filter.

The Worcester experiments indicate a similar result, and at times the 10-ft. filter was producing a stable effluent at higher rates per cubic yard than the shallower filters.

TABLE I.

WORK ACCOMPLISHED BY TRICKLING FILTERS OF DIFFERENT DEPTHS.

Location.	Filter No.	Depth. Ft. In.	Size of Stone. Inches.	Nitrogen Applied. Grams per Cu. Yd.	Cu. Yds. Filtering Material Required per Person.	Per Cent. of Samples Stable.	Period of Operation.	Character of Sewage Applied.
Gloversville, N. Y.	3	5–0	$1\frac{1}{2}$–2	6.90	2.2	32.2	3 months	Septic
Gloversville, N. Y.	2	7–0	$1\frac{1}{2}$–2	5.96	2.5	100	3 months	Septic
Gloversville, N. Y.	1	10–0	$1\frac{1}{2}$–2	6.95	2.2	91.6	3 months	Septic
Worcester, Mass.	D	5–0	$\frac{3}{4}$–$2\frac{1}{2}$	10.52	1.4	70	1 year	Settled
Worcester, Mass.	F	7–6	$\frac{3}{4}$–$2\frac{1}{2}$	10.02	1.5	93	2 months	Settled
Worcester, Mass.	E	7–6	$\frac{1}{2}$–$1\frac{1}{2}$	11.0	1.4	100	1 year	Settled
Worcester, Mass.	H	10–0	$\frac{3}{4}$–$2\frac{1}{2}$	10.40	1.4	88.9	4 months	Imhoff tank
Worcester, Mass.	G	10–0	$\frac{1}{2}$–$1\frac{1}{2}$	10.4	1.4	100	4 months	Imhoff tank
Lawrence, Mass.	247	5–0	$\frac{1}{4}$–1	25.7	0.6	40–78	3 years	Unsettled
Lawrence, Mass.	248	8–0	$\frac{1}{4}$–1	16.6	0.9	90–100	3 years	Unsettled
Lawrence, Mass.	248	8–0	$\frac{1}{4}$–1	25.4	0.6	90–100	4 years	Settled
Lawrence, Mass.	135	10–0	$\frac{1}{4}$–1	16.4	0.9	100	1 year	Unsettled
Lawrence, Mass.	136	10–0	$\frac{1}{4}$–1	28.2	0.5	100	2 years	Settled
Lawrence, Mass.	136	10–0	$\frac{1}{4}$–1	29.7	0.5	70	1 year	Settled
Lawrence, Mass.	136	10–0	$\frac{1}{4}$–1	22.6	0.7	100	3 years	Unsettled
Lawrence, Mass.	135	10–0	$\frac{1}{4}$–1	19.1	0.8	100	4 years	Settled
Lawrence, Mass.	135	10–0	$\frac{1}{4}$–1	17.0	0.9	100	1 year	Settled
Lawrence, Mass.	135	10–0	$\frac{1}{4}$–1	18.7	0.8	100	4 years	Settled

The experiments made at Lawrence, Mass., and given in Table 1, also indicate the same results, that up to a limit of depth of 10 ft. the capacity of a trickling filter is directly proportional to its depth.

There may be a greater tendency to pooling with the deep filter on account of the greater quantity of sewage applied per unit of superficial area and a slightly less circulation of air; but, on the other hand, the deep filter may have some advantage because of the lessened effect of low temperatures of winter in severe climates, and a smaller surface area from which odors are likely to be given off.

From the foregoing it seems that there is at least as good ground for assuming that a filter 10 ft. in depth will do as much work per cubic yard of stone as one 6 ft. in depth, as there is for Mr. Fuller's assumption that the unit capacity of a filter decreases with its depth in 6-, 8-, and 10-ft. beds. The importance of this difference in assumptions is very great, as will be shown by a comparison of the cost of filters of various depths.

In making such a comparison, it would seem to be more accurate to vary the cost of the walls according to their length and height, rather than in proportion to the cubic yards of stone contained in the filter, as was done by Mr. Fuller. The difference, however, is not great.

In computing the comparative costs of the distribution system, Mr. Fuller assumed that they vary only according to the quantity delivered and that they must be the same per cubic yard for all effective depths. It seems to the writer that this is a wrong assumption and that the distribution system is much more likely to vary in proportion to the area of the filter.

The comparative costs of filters from 6 to 10 ft. deep (the 10-ft. filter computed by the writer), based upon Mr. Fuller's assumptions and those of the writer, are given in Tables 2 and 3, the unit prices being those adopted by Mr. Fuller.

The unit prices assumed in the paper are extremely low, and it may be of interest to make similar computations based on the prices actually bid for the construction of the sewage treatment works at Fitchburg, Mass., which have just been completed. Such comparisons figured by the methods proposed by

TABLE 2.

RELATIVE COSTS OF TRICKLING FILTERS OF DIFFERENT DEPTHS. BY GEORGE W. FULLER.*

	Cost per Effective Cu. Yd.			
Depth of stone in feet	6	7	8	10
Floor at $0.40 per cu. yd. for 6-ft. bed	$0.40	$0.35	$0.32	$0.29
Tile at 11c per sq. ft.	.49	.44	.40	.36
Walls at cost $0.17 per cu. yd. for 6-ft. depth	.17	.17	.18	.21
Galleries and collectors at $0.25 per cu. yd. for 6-ft. depth	.25	.22	.20	.18
Distribution at $0.50 per cu. yd., same for all effective depths per cu. yd.	.50	.50	.50	.50
Stone at $1.50 per cu. yd.	1.50	1.55	1.60	1.83
Total	$3.31	$3.23	$3.20	$3.37

NOTE: Fuller assumes relative value of stone per cubic yard to be as follows:

Depth of bed	6 ft.	7 ft.	8 ft.	9 ft.	10 ft.	12 ft.
Value	1.0	0.97	0.94	0.92	0.82	0.63

In computing relative costs, the unit costs for 6-ft. filter are decreased where necessary, in proportion to the volume of the deeper filters, and divided by the above factors.

TABLE 3.

COST OF TRICKLING FILTERS OF VARIOUS DEPTHS PER EFFECTIVE CU. YD. BY EDDY'S METHOD, BASED ON FULLER'S PRICES.

Depth of stone in feet	6	7	8	10
Relative value of stone per cu. yd.	1.0	1.0	1.0	1.0
Relative volumes of stone	1.0	1.0	1.0	1.0
Relative areas of filtering surface	1.0	0.857	0.75	0.60
Relative extent of walls (area)	1.0	1.12	1.15	1.29
Floor at 40c per cu. yd. 6-ft. filter	$0.40	$0.34	$0.30	$0.24
Tile at 11c per sq. ft.	.49	.44	.40	.36
Walls at 17c per cu. yd. 6-ft. filter	.17	.19	.20	.22
Galleries and collectors at 25c per cu. yd. 6-ft. filter	.25	.21	.19	.15
Distribution at 50c per cu. yd. 6-ft. filter,	.50	.43	.38	.30
Stone at $1.50 per cu. yd.	1.50	1.50	1.50	1.50
Total	$3.31	$3.11	$2.97	$2.77

NOTE: In computing this table the unit costs of a 6-ft. filter are decreased where necessary, in proportion to the quantity, as of floor area per cubic yard of stone, and divided by Fuller's factors.

Mr. Fuller and the writer, respectively, are given in Tables 4 and 5. From these figures it will be seen that whereas on Mr.

* Computations relating to filter 10 ft. deep made by writer.

Fuller's assumption the price per effective cubic yard varies relatively little, from $4.33 to $4.56, when computed on the

TABLE 4.

COST OF TRICKLING FILTERS OF VARIOUS DEPTHS PER EFFECTIVE CU. YD., BY GEO. W. FULLER'S METHOD BUT BASED ON FITCHBURG PRICES.

Depth of stone in ft.	6	7	8	10
Relative value of stone per cu. yd.	1.0	0.97	0.94	0.82
Relative volumes of stone	1.0	1.03	1.06	1.22
Relative areas of filtering surface	1.0	0.88	0.80	0.73
Floor at $1.30 per cu. yd. for 6-ft. filter varies as area	$1.30	$1.14	$1.04	$0.95
Walls at 14½c per cu. yd. for 6-ft. filter (varies as volume of stone)	.15	.15	.15	.18
Underdrains and gallery at 34c per cu. yd. 6-ft. filter (varies as area)	.34	.30	.27	.25
Distribution at 80c per cu. yd. 6-ft. filter (constant)	.80	.80	.80	.80
Stone at $1.95 per cu. yd.	1.95	2.01	2.07	2.38
Total	$4.54	$4.40	$4.33	$4.56

TABLE 5.

COST OF TRICKLING FILTERS OF VARIOUS DEPTHS PER EFFECTIVE CU. YD., BY EDDY'S METHOD BASED ON FITCHBURG PRICES.

Depth of stone in feet	6	7	8	10
Relative value of stone per cu. yd.	1.0	1.0	1.0	1.0
Relative volumes of stone	1.0	1.0	1.0	1.0
Relative areas of filtering surface	1.0	0.857	0.75	0.60
Relative extent of walls (area)	1.0	1.12	1.15	1.29
Floor at $1.30 per cu. yd. 6-ft. filter (varies as area)	$1.30	$1.11	$0.98	$0.78
Walls at 14½c per cu. yd. 6-ft. filter (varies as walls)	.15	.17	.17	.19
Underdrains and gallery at 34c per cu. yd. 6-ft. filter (varies as area)	.34	.29	.26	.20
Distribution at 80c per cu. yd. 6-ft. filter (varies as area)	.80	.69	.60	.48
Stone at $1.95 per cu. yd. (varies as volume of stone)	1.95	1.95	1.95	1.95
Total	$4.54	$4.21	$3.96	$3.60

assumptions made by the writer the differences are substantial, the range in price being from $3.60 for the 10-ft. filter to $4.54 for the 6-ft. filter.

This may be presented in a somewhat more effective manner by applying the prices to filters of varying depths, capable of doing the same work as a filter one acre in area and 6 ft. deep. These computations are given in Table 6, from which it appears

TABLE 6.

COST OF TRICKLING FILTERS OF VARIOUS DEPTHS TO DO THE WORK OF 1 ACRE, 6 FEET DEEP.

(Assume filters square in plan.)

Depth of stone in feet	6	7	8	10
Relative value of stone per cu. yd. (H.P.E.)	1.0	1.0	1.0	1.0
Relative volumes of stone	1.0	1.0	1.0	1.0
Relative areas of filtering surface	1.0	0.857	0.75	0.60
Relative extent of walls (areas)	1.0	1.12	1.15	1.29
Floor system at $2.60 per sq. yd.	$12 580	$10 780	$9 440	$7 540
Walls at $2.00 per sq. yd. (718 sq. yd. in 6-ft. filter)	1 436	1 608	1 650	1 852
Underdrains and gallery at 68½c per sq. yd. (area)	3 315	2 840	2 480	1 988
Distribution system at $1.60 per sq. yd. (area)	7 773	6 666	5 830	4 666
Stone at $1.95 per cu. yd.	18 880	18 880	18 880	18 880
Total, exclusive of engineering and excavation	$43 984	$40 774	$38 280	$34 926

that a filter 10 ft. deep need have an area but six tenths as great as that of a filter 6 ft. deep. It is, therefore, to be expected that the cost of floor system, underdrains, galleries and distribution system will be materially less in the case of the deeper filter, while the cost of the walls for the deeper filter will be increased. If the assumptions upon which these computations have been based are correct, the cost of a filter 10 ft. in depth, to do the work which could be accomplished by a filter one acre in area and 6 ft. deep, will be $34 926, whereas the filter 6 ft. deep would cost $43 984. The reduction in cost, therefore, amounts to slightly over 20 per cent. All of these computations are exclusive of excavation.

It is unfortunate that there are no better data upon which to predicate an assumption as to the relative capacities per cubic yard of filtering media in deep and shallow filters. There

can be no doubt that there is a practical limit to the economic depth of trickling filters. This limit will vary according to local conditions and must be computed for each case. There seems to the writer, however, much evidence that up to a certain limit, which in most cases where municipal sewage is to be treated will be as high as 8 or 10 ft., the capacities of the filters will be approximately uniform per cubic yard of filtering material.

This brief paper is presented with a view to pointing out the importance of the difference between the two theories described, with a hope that some one will have an opportunity to carry out for a considerable period of time a series of experiments to determine the point at issue. Conclusions as to the efficiency of filters — particularly deep ones — must not be based upon too short periods of operation, for it takes considerable time for a deep filter to become thoroughly seeded throughout its depth, and until it does it cannot do its normal amount of work.

Since preparing the foregoing paper the writer's attention has been directed to a reprint from the Forty-fifth Annual Report of the Massachusetts State Board of Health, recently issued for distribution. In this report, Messrs. H. W. Clark and Stephen DeM. Gage describe the beginning of an experiment to determine the "relative rates necessary to obtain effluents of equal quality from trickling filters of different depths." This experiment appears to be exactly in accord with that suggested in the foregoing discussion. These filters are 4, 6, 8 and 10 ft. in depth, respectively, and the results at the end of the period covered by the report — May 1, 1913, to December 1, 1913 — appeared to indicate that the deeper filters had a capacity per cubic yard at least equal to, if not greater than, the similar capacities of the shallower filters. The results of the past year (1914) will prove of great interest and, in the writer's opinion, of distinct value as furnishing reliable information upon this important subject.

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BOSTON SOCIETY OF CIVIL ENGINEERS
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PAPERS AND DISCUSSIONS

THE DEPTH OF FILTERING MATERIAL AND TRICKLING FILTER EFFICIENCY.

BY H. W. CLARK, MEMBER, BOSTON SOCIETY OF CIVIL ENGINEERS.

(Presented before the Sanitary Section, December 9, 1914.)

THE maximum results in efficiency of purification and volume of sewage purified in trickling filter sewage purification are obtained when the filter is of considerable depth and is constructed of comparatively fine material. There is undoubtedly a maximum depth beyond which the additional efficiency obtained is not commensurate with the additional cost of construction, and which interferes with filter aëration, and a minimum depth below which economical rates of filtration cannot be maintained. In coördination with the depth, a filtering material should be selected that will have the greatest efficiency at that depth when the filter is operated at economical rates and yet be coarse enough to preclude clogging of the filter and, if possible, surface pooling.

During a period of sixteen years, broken stone trickling filters have been operated at Lawrence, constructed with depths of material varying from 4 to 10 ft. and with stone varying from 1 in. to 6 ins. in diameter. The rates of operation have varied

NOTE. Discussion of this paper is invited, to be received by Edward C. Sherman, Editor, 6 Beacon Street, Boston, by April 15, 1915, for publication in a subsequent number of the JOURNAL.

from 250 000 to 10 000 000 gals. per acre daily. Three of these filters, 5, 8 and 10 ft. in depth and operated for periods of five, eleven and fifteen years, respectively, gave average rates and results during these periods of operation shown in the following table.

TABLE 1.

Filter No.	Depth. (Ft.)	Period of Operation. (Years.)	Average Rate. (Gallons per Acre Daily.)	Nitrates. (Parts per 100 000.)	Percentage of Stability.
247	5	5	1 465 000	0.97	44
248	8	11	1 630 000	1.00	90
135	10	15	2 000 000	2.10	99+

These three filters, used for various studies of trickling filter purification, received at different times sewage of varying strength, and hence the results in regard to purification and stability of effluents are not strictly comparable with their rates of operation. However, the table shows that with the sewage applied, the 5-ft. filter was operated at a rate altogether too high to obtain suitable stability of effluent, that the 8-ft. filter gave fairly satisfactory results even at the high average rate maintained and that the 10-ft. filter could have been operated at a much higher rate and still have produced a stable effluent.

On May 1, 1913, four new trickling filters were put into operation at the station to study this point; namely, to determine at what rates filters constructed of different depths and of the same material must be operated in order to obtain effluents of equal quality. Each of these filters is constructed of pieces of broken stone between $\frac{3}{4}$ in. and $1\frac{1}{2}$ in. in size. Filter No. 452 is 4 ft. in depth; Filter No. 453, 6 ft.; Filter No. 454, 8 ft.; and Filter No. 455, 10 ft. The sewage applied to each has been clarified by sedimentation. We have attempted to operate each filter at such a rate that the effluents will contain about 1.5 parts nitrates per 100 000, this being the amount of nitrification which previous experience at the station has shown to be necessary in order to insure stable effluents in trickling filter

purification. Each filter was operated at first at a rate of 1 000 000 gals. per acre daily. On August 15, 1913, the two deep filters — Nos. 454 and 455 — were producing well-nitrified effluents, and the rate of each was increased to 1 250 000 gals. per acre daily. As the two shallow filters had not up to this time given satisfactory results, the rate of No. 452, the 4-ft. filter, was reduced to 500 000 gals., and that of No. 453, the 6-ft. filter, to 800 000 gals. per acre daily, and later to 140 000 and 200 000 gals. per acre daily, respectively. Even at these low rates, however, the effluents from these two shallow filters did not average up to the required standard of stability and nitrification. Nitrification in the deep filters continued to increase, and during October and the early part of November the rate of the 8-ft. filter was gradually advanced to 2 000 000 gals., and that of the 10-ft. filter to 2 500 000 gals. per acre daily.

The average rates of operation and analyses of the effluents from these filters during this first year are given in the following table. In this table the percentage of stability given to the effluents of the shallow filters is due to the fact that during a considerable portion of this period they were being operated at rates much lower than the averages given in the table.

TABLE 2.

Average Analyses of Effluents.

(Parts per 100 000.)

Filter No.	Depth. Ft.	Quantity Applied. Gallons per Acre Daily.	Ammonia, Albuminoid.			Chlorine.	Nitrates.	Oxygen Consumed.	Percentage of Stability.
			Free.	Total.	In Solution.				
452	4	637 100	1.4083	.2858	.1947	14.33	1.08	1.98	83
453	6	798 000	1.3442	.1958	.1467	14.23	1.04	1.37	90
454	8	1 231 300	0.9542	.2168	.1560	14.14	1.53	1.65	99+
455	10	1 355 300	0.9833	.2533	.1773	13.87	1.85	1.89	99+

Early in 1914 these filters reached a condition of equal biological activity and it was possible to so adjust their rates that practically equal effluents were obtained, and the results for this year are shown in Table 3.

TABLE 3.

AVERAGE CHEMICAL ANALYSES OF EFFLUENTS FROM DECEMBER, 1913, TO SEPTEMBER, 1914, INCLUSIVE.

(Parts per 100 000.)

Filter No.	Quantity Applied. Gallons per Acre Daily.	Ammonia, Albuminoid.			Chlorine.	Nitrogen as		Oxygen Consumed.	Percentage of Stability.
		Free.	Total.	In Solution.		Nitrates.	Nitrites.		
452	332 700	1.8600	.3050	.2006	13.20	1.63	.0065	1.89	85
453	585 100	1.2900	.2950	.1796	13.30	1.81	.0128	1.79	91
454	1 801 000	1.3575	.3715	.2292	12.98	1.66	.0126	2.17	88
455	3 733 000	1.7275	.3900	.2616	13.48	1.76	.0081	2.38	85

Table 4 is of interest in showing the lower nitrification and stability of effluent of the two shallower filters when operated at rates considerably higher than the yearly average.

TABLE 4.

AVERAGE CHEMICAL ANALYSES OF EFFLUENTS FOR TWO MONTHS WITH HIGHER RATES OF FILTRATION.

(Parts per 100 000.)

Filter No.	Quantity Applied. Gallons per Acre Daily.	Ammonia, Albuminoid.			Chlorine.	Nitrogen as		Oxygen Consumed.	Percentage of Stability.
		Free.	Total.	In Solution.		Nitrates.	Nitrites.		
452	524 000	2.6250	.3425	.2320	13.00	0.94	.0070	2.00	56
453	721 000	1.9500	.3300	.2200	12.70	1.21	.0070	1.88	67

CONCLUSIONS.

All of these filters are constructed of comparatively fine broken stone averaging about one inch in diameter, and they are, of course, operated under ideal conditions; that is, under such supervision and care as is almost impossible to actually duplicate in practice. This does not affect their comparative

results, however. Judging from these results, the deeper filters are much more economical than the shallower filters as they allow greater rates, foot for foot. The maximum average rate of filtration per foot of depth with filters of the depths studied, with equal nitrification and stability of effluent, during 1914, was as shown in the following table. In this table are also presented figures showing what probably will be the average rate of filtration per foot in depth with these filters after they have been in operation for a longer period. It is evident from these figures and those in Table 3 that the rates of filtration that can be maintained increase much faster than the depths.

TABLE 5.

GALLONS FILTERED PER ACRE DAILY PER FOOT OF FILTER DEPTH, WITH EQUAL NITRIFICATION AND STABILITY RESULTS.

	According to 1914 Rates.	According to Probable Rates over a Considerable Period.
With a 4-ft. filter	85 000	100 000
With a 6-ft. filter	100 000	125 000
With an 8-ft. filter	225 000	200 000
With a 10-ft. filter	370 000	300 000

In Table 6, figures are given showing the actual increase in volume of sewage per acre that can be filtered daily for each foot in depth additional above six feet and above eight feet in depth; that is, judging from these 1914 results. Moreover, studying certain previous work with trickling filters at Lawrence, this remarkable increase of efficiency in rate purification of the deeper filters seems to hold true.

TABLE 6.

Gain in Actual Rates of Filtration per Acre for Each Foot.	Gallons per Acre Daily.
Above 6 ft. in depth	550 000
Above 8 ft. in depth	750 000

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PAPERS AND DISCUSSIONS

DISCUSSION OF THE ECONOMIC DEPTH OF TRICKLING FILTERS.

MR. GEORGE W. FULLER (*by letter*). — The writer has read with keen interest the paper of Mr. Eddy upon the "Economic Depth of Sprinkling Filters" and has noted in particular the position taken that there is much evidence to show that up to a certain limit, in most cases as high as 8 or 10 ft., the capacities of filters of this type will be approximately uniform per cubic yard of filtering material. From this deduction it follows that economically it is preferable, where the head is available, to build sprinkling filters of greater depth than the 7-ft. limit suggested in an earlier paper by the writer on the "Economics of Sewage Filters," presented last October before the American Society of Municipal Improvements.

The writer agrees with the majority of the points set forth by Mr. Eddy. It goes without saying that the conclusions should and would be identical if the premises were the same. The writer based his views partly on general observation of European and American filters on a practical scale, but more particularly upon the data from experimental filters at Baltimore and the results obtained from the first large sprinkling filter on a working scale in this country at Reading, Pa. Mr. Eddy bases his views upon data from Gloversville, Worcester and Lawrence, but with a different yardstick for measuring relative efficiencies.

There is agreement on the proposition that this question

is an important one and that the available data of a directly comparable nature are very meager and, in fact, almost lacking save for the interesting small-scale tests at Lawrence, conducted for a fairly short period, as outlined by Mr. Clark. The writer also agrees that this question is one for detailed study on each large project and that the conclusions deduced for one project are not necessarily correct for another problem under different local conditions.

Our comments after re-reading the original paper and Mr. Eddy's discussion thereof are as follows:

Prevailing Practice.

Within the range of the writer's observation the vast majority of sprinkling filters have a depth ranging from about 5 ft. to 8½ ft. Exceptions to this range are to be found for deeper filters in the case of very coarse material called by the Germans "fist size"; or with very fine material, such as noted in the shallow beds of fine saggars at Hanley, England. Excepting Mr. Eddy's important project at Fitchburg, Mass., most of the recent sprinkling filters in this country have been based on a depth of 6½ to 7 ft. There are a few with shallower depths, necessitated by local conditions as to available head, such as at Schenectady, N. Y. The 8½-ft. beds at Baltimore were occasioned largely by the desire to get a removal of bacteria somewhat greater than ordinarily had been the experience with shallower beds elsewhere.

The writer attaches much importance to the fact that the sprinkling filters at Reading, Pa., have required progressively the installation of additional units, due to the existing ones receiving as high a load as could be safely carried without unreasonable pooling and clogging at the surface. In other words, if the beds were materially deeper, it does not seem likely that any more sewage could have been rendered non-putrescible, although it is granted that a higher degree of nitrification would have been found in the effluent. It is realized, however, that this deduction is not necessarily decisive on broad lines, because with the elimination of some of the finer particles of the Reading

filtering material the clogging factor would have been somewhat reduced.

Speaking generally, the Fitchburg design and the teachings of the experiments as described in Mr. Eddy's discussion point to a departure from what might be called normal practice, and it is believed to be fair to point out that while the data are admittedly incomplete, the burden of proof rests with those making the departure from prevailing practice. Particularly is this so, as the data of Mr. Eddy are at variance with those from Baltimore, as given by the writer, and those from Hanley and Leeds, England, as summarized by Kinnicutt, Winslow and Pratt.*

Duration of Tests.

Mr. Eddy is correct in pointing out that this is an item of much significance. Nitrification in the lower portions of deep beds is probably not established until some time after the filter is put in service. On the other hand, surface clogging does not develop until the plant has been in service for some time.

Uniformity of distribution of sewage is another item of importance. It is influenced by surface clogging to some extent, but it is true that deeper beds have a steadying influence on distribution which is more marked than in the case of shallow beds, other things being equal.

These comments are made in particular to point out that too much weight should not be given to the results obtained from small-scale tests of relatively short duration.

Comparison of Efficiency.

The inadequacy of the yardstick for measuring the relative efficiency of sprinkling filters of different depths is one of the chief factors in causing discordant data and varying conclusions to be drawn thereform. It is one of the differences between the writer's comments on the Baltimore data and the statements of Mr. Eddy concerning the Gloversville, Worcester and Lawrence data. The writer has dealt with relative

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*"Sewage Disposal," page 332.

stability and oxygen-consumed results, whereas Mr. Eddy has measured the work accomplished by the percentage of samples showing the effluent to have been stable. The strength of the sewage he has measured in terms of unoxidized nitrogen, including free ammonia and organic nitrogen.

The uncertainties attending this method of rating the work accomplished may readily disguise the well-known fact that the upper portions of the filters generally do more work than the lower portions. This latter statement is based partly upon the results of inspection showing a greater detention of organic matter and zooglœa which, so long as aëration is ample, we have been taught to believe promotes biochemical activities accomplishing purification to a greater extent than is effected by passing over the cleaner stone in the lower portion of the filter. This may not be true as regards complete nitrification, but it is believed to be so so far as freeing the sewage of putrescible organic matter is concerned. It is generally supported by the Hanley and Leeds data, cited above.

Significance of Nitrification.

The Massachusetts data, especially those at Lawrence, seem to be interpreted as regards efficiency of coarse-grained filters, with a higher regard for nitrification than is true at many places elsewhere. Thus it is stated that the Lawrence filters were subjected to an operating schedule such as to cause the effluents to contain about 1.5 parts per hundred thousand of nitrogen as nitrates. This is quite a different policy from that adopted by the writer. At Reading, Pa., for instance, as described in the writer's book on "Sewage Disposal," page 695, the sprinkling filter effluents were uniformly stable and did not on an average contain half as much nitrates as above-mentioned. Quoting again from the same book, it is noted on page 674 that the Plainfield filters contain only about one quarter as much nitrates as mentioned in the Lawrence procedure, although the effluents as a rule were non-putrescible. During the summer months the final effluent, undiluted, was occasionally putrescible, but this was rarely if ever the case during the eight colder months of the year.

Attention here is directed to the fact that low nitrification in the sand filters at Lawrence during the winter of 1901–02 accompanied non-putrescible effluents, as stated in the 1901 Report of the Massachusetts State Board of Health, page 308, and in the 1902 Report, page 214.

Nitrates unquestionably promote the stability of the effluents of coarse-grained filters, but where the effluent is well supplied with dissolved oxygen there are grave doubts in the mind of the writer as to whether it is economically practicable to design and operate a sprinkling filter so as to promote relatively high nitrification.

Undoubtedly we are in need of more reliable means for measuring the practical results accomplished in removing the objectionable putrefying constituents of sewage. The "Saltpeter Method for Determining the Strength of Sewages," as presented in Dr. A. Lederer's recent notes on this subject, may put a different aspect on these comparative studies.

Quality of Sewage.

Undoubtedly the age, strength and character of the applied sewage are factors to be considered in dealing with the work accomplished by sprinkling filters. It is quite significant to the writer's thought that the sewage applied to the test filters at Baltimore was very fresh sewage from a small suburban area immediately adjoining the station. The sewage at Reading and Plainfield is also relatively fresh. At Lawrence the sewage is stale and more or less advanced along the lines of anaërobic decomposition. This was true as described by the writer in the 1894 Report of the Massachusetts State Board of Health, page 459. This "staleness" of the Lawrence sewage has quite likely increased rather than decreased in recent years. The sewages at Worcester and Gloversville are characterized by their mixture with trade wastes, and these may have been factors of substantial significance.

The English data, quoted by Mr. Eddy to the effect that the work accomplished by sprinkling filters is substantially the same per volume of material, were presumably obtained with

stale rather than fresh sewage. Perhaps the long period of travel of the Lawrence sewage through the 4 000-ft. length of galvanized-iron pipe may be a factor explaining the data pointing to a result different from the English conclusion and diametrically opposed to the data from Baltimore, Reading, etc. Lack of aëration of the influent, such as furnished by sprinkler nozzles elsewhere, may be of significance.

Relative Purification by Royal Commission Standards.

In the absence of any definitely accepted method of comparing purification effected by filters, the writer has had his staff study the use of the proposed Royal Commission method for this purpose. This method is not presented by its author, Dr. McGowan, as being at all conclusive, and it is based, of course, on a limited number of experimental data; nevertheless, it has the merit of being suitable for quantitative comparison. This Royal Commission method is an attempt to put in numerical form the various elements entering into the strength of a sewage applied to a filter and the effluent coming from a filter and, combining these figures for strength or oxidizability with the rate of dosing of the sewage, there is obtained a definite numerical purification figure which is said to be suited for comparative work.

This method, originated by Dr. George McGowan, may be found in the Fifth Report of the Royal Commission on Sewage Disposal, on pages 16 and 107. Detailed information with the bases on which the formulæ used are derived may be found in the Fourth Appendix to the Fifth Report of the Royal Commission on Sewage Disposal, particularly pages 1 to 50.

The oxidizability, which is called the strength of the sewage applied, is to be measured by the following formula:

$$S = (\text{Ammon. N} + \text{Organic N}) \times 4.5 + (\text{Oxygen absorbed in 4 hours}) \times 6.5.$$

Nitrogen and oxygen are to be expressed in parts per 100 000.

The strength of a filtered effluent is measured by Dr. McGowan as follows:

$$\begin{aligned}\text{Strength} = &\ (\text{Ammon. N} + \text{Organic N}) \times 4.5 \\ &+ (\text{Vol. matter of suspended solids}) \times 2 \\ &- \text{nitric nitrogen} \times 3.\end{aligned}$$

The amount of purification effected, or, as expressed by Dr. McGowan, the unit of purification per cubic yard of material, is equal to the difference in strength between the influent and effluent, multiplied by the gallons of sewage per cubic yard of material treated per day.

The theory on which these formulæ is based is that the so-called strength of either influent or effluent, as expressed by the formula, is equal to the amount of oxygen in parts per 100 000 required completely to oxidize the sewage. In the formula for the effluent a deduction is made for the oxygen present in the form of nitrates by deducting three times the nitric nitrogen from the strength as shown by the other part of the formula. The difference between the strength of the influent and the effluent represents the loss of oxidizability in parts of oxygen per 100 000 effected by the purification treatment.

The writer uses the above-stated formula in analyzing the various observations which have been made in this country. In this connection he wishes to call attention to the fact that in the formula for the strength of sewage effluents from filters a subtraction is made corresponding to the amounts of nitrates present, and as it is well known that a deep filter effects a relatively higher degree of nitrification than shallow filters, this deduction for nitrates favors relatively the deep filter. A later suggestion of Dr. McGowan is to be found on page 50 of the Fourth Appendix to the Fifth Report, as follows:

"With regard to the calculation of the unit of purification per cubic yard of filter, we think — on further consideration — that it would be more correct not to give credit for the nitrate remaining in the effluent. The strength of a sewage liquor is based upon the amount of oxygen required for the complete oxidation of the liquor by atmospheric or dissolved oxygen, the nitrogen (at all events, much the greater part of it) remaining in the diluted liquid in the form of nitrate."

If this modified form of strength formula were to be used,

not making deduction from the strength of the effluent because of the nitrates present, the resultant figures would be more favorable to the form of filter effecting the smaller amount of nitrification. The writer does not, however, use this modified formula, but uses the original form and wishes only to call attention to the fact that the error in using the original form, if any, as between the original formula and the one later suggested by Dr. McGowan, favors the deep filter as compared with the shallow one.

Examining first the data presented in Table 1 of Mr. Eddy's paper, we find records given for the Gloversville experimental plant for a period of three months for each of the three filters. The writer does not wish to question the correctness of these records as reported by Mr. Eddy, for the particular time which these records cover, and no doubt from Mr. Eddy's familiarity with this experimental plant he has given correct figures, but the writer has been unable to find these figures in the original 1909 printed Gloversville report and has been compelled to take from this original printed report figures as reported in order to use Gloversville tests for comparative purposes. Taking practically the whole run of these filters Nos. 1, 2 and 3 for a period of ten months beginning at the beginning of September, 1908, and ending at the end of June, 1909, and taking the rate of filtration as given in Appendices I, J and K, pages 211 to 250 inclusive, of the report, we get the following Table 1.

The quality of the influent to the filters and the effluent from the filters is to be found in this 1909 report as follows. For filter No. 1, on page 100; filter No. 2, on page 103; filter No. 3, on page 104. The tables on these three pages give what is called the averages of all analyses of influent and effluent. These averages may not be absolutely identical for the same period as those of the average rate shown here in Table 1, and it may extend for a somewhat longer period than that of Table 1. There is no reason, however, to expect that there will be any substantial difference, and we can practically take the analyses of these pages quoted as corresponding to the rate of Table 1.

Using the analyzed results, Table 2 following shows the purification effected by each of the three filters in question:

TABLE 1.

AVERAGE RATE OF FILTRATION, IN MILLION GALLONS PER ACRE DAILY, GLOVERSVILLE EXPERIMENTAL FILTERS.

Month.	Filter No.		
	1.	2.	3.
September, 1908	0.60	0.69	0.60
October	0.78	0.78	0.70
November	1.00	1.00	1.00
December	1.18	1.06	1.00
January, 1909	1.18	1.06	1.00
February	1.18	1.06	1.00
March	1.18	1.06	1.00
April	1.18	1.06	1.00
May	1.18	1.06	1.00
June	1.18	1.06	1.00
Average	1.06	0.99	0.93

TABLE 2.

GLOVERSVILLE EXPERIMENTAL FILTERS. RECEIVING SEPTIC TANK SEWAGE.

	Filter No.		
	1.	2.	3.
Depth of stone, feet	10	7	5
Size of stone, inches	$1\frac{1}{2}$–2	$1\frac{1}{2}$–2	$1\frac{1}{2}$–2
Rate of dosing, m.g.d. acre	1.06	.99	.93
Rate of dosing, gallons per cu. yd. per day,	66	88	115
Influent: Free ammonia, ppm	14	15.2	14
Organic nitrogen, ppm	14	15.3	14
Oxygen consumed (5 min. boiling), ppm	61	68	62
Strength, $\frac{4\frac{1}{2}(N+O)}{10}$, pp 100 000	38.8	40.2	39.4
Effluent: Free ammonia, ppm	8.0	8.6	11.5
Organic nitrogen, ppm	3.5	5.0	5.8
Nitrates, ppm	4.8	3.6	1.6
Volatile suspended solids, ppm	22	32	29
Strength, $\frac{4\frac{1}{2}N+2V-3n}{10}$, pp 100 000	7.6	10.7	12.2
Reduction of strength	31.2	29.5	27.2
Purification units per cubic yard daily	2 060	2 600	3 130

In considering the data of these experiments, it is to be noted that the oxygen-consumed test is given on the basis of the oxygen taken from permanganate on five minutes' boiling. This oxygen figure will be materially greater than will be obtained by the four-hour test used as the basis in the English formula, and to make allowance for the different figures the writer has used a multiplier of 4.5 instead of 6.5 for the oxygen consumed. This may not be at all exact, but the error introduced is not substantial, and should not materially affect the result.

On the basis of all the Gloversville tests recorded, it seems that stone in the 10-ft. filter effects the purification of 2 060 units per cubic yard per day; in a 7-ft. filter, 2 600 units; and in the 5-ft. filter, 3 130 units.

Passing now to the next series of data reported by Mr. Eddy, the test of the Worcester, Mass., filters, here again the writer is unable to identify the particular period covered by these tests reported by Mr. Eddy and is unable to test the accuracy of the figures shown or to judge them by his own methods of computation. The results reported for the deep filters seem to be substantially better than those of the shallow filters. There are some variable factors, however, in these tests which make the comparison as reported unsatisfactory. The biggest item of difference appears in the Table 1 of Mr. Eddy's paper, where it is stated that the sewage applied to Filters D, F and E is settled sewage and the sewage applied to Filters G and H, the deeper filters, is the effluent from Imhoff tanks. The fact that the tests are not made at the same time makes comparison a very difficult matter. Another factor is stated in Mr. Fales's report appended to the annual report of the superintendent of sewers of Worcester for the year ending November 30, 1912, on pages 57 and 58, where he states:

"In considering the relative efficiency of the 10-ft. filter, conditions of operation must again be taken into account. During the operation of the 10-ft. filter, Worcester nozzles have been in use, and the distribution has been much better than we have ever attained before. It is probable that the increased efficiency of the filter is due largely, if not solely, to the improvement in the distribution."

Still another difficulty in the proper comparison of these tests is the fact that the effluent analysis reported is the analysis with the suspended matters in the effluent removed by sedimentation. This will effect an apparent increase in the purification units to be obtained from each filter, but it is not known whether this increase will be the same for all filters and for the whole period covered by the tests.

The writer feels that the tests as reported are not in such shape that a comparison will lead to any final conclusion; he gives the figures of these tests below and the calculations obtained from them for the sake of completeness in the following table.

The shallow filters, Filters D, E and F, have results reported in the annual report of the superintendent of sewers for the year ending November 30, 1910, page 748. Table 3 gives the data and calculations obtained from this series of tests.

TABLE 3.

WORCESTER EXPERIMENTAL FILTERS RECEIVING SETTLED SEWAGE.
SEPTEMBER, 1909, TO SEPTEMBER, 1910.

(All data in parts per 100 000.)

	Filter No.		
	D.	E.	F.
Depth of stone, feet	5.0	7.5	7.5
Size of stone, inches	$\frac{3}{4}$–$2\frac{1}{2}$	$\frac{1}{2}$–$1\frac{1}{2}$	$\frac{3}{4}$–$2\frac{1}{2}$
Rate of dosing, m.g.d. acre	.70	1.00	1.00
Rate of dosing, gallons per cu. yd. per day,	93	83	83
Influent: Free ammonia	2.70	2.70	2.70
Albuminoid ammonia	.52	.52	.52
Residual organic nitrogen	.66	.66	.66
Oxygen consumed (2 min. boiling)	8.05	8.05	8.05
Strength, $4\frac{1}{2}N+6\frac{1}{2}O$	67.1	67.1	67.1
Effluent: Free ammonia	2.13	1.85	1.83
Albuminoid ammonia	.17	.13	.13
Residual organic nitrogen	.16	.13	.16
Nitrates	.23	.47	.34
Strength, $4\frac{1}{2}N-3n$	8.6	6.4	7.4
Reduction of strength	58.5	60.7	59.7
Purification units per cu. yd. per day	5 400	5 000	4 950

In these Worcester tests the oxygen consumed is reported by the two minutes' boiling method. It is assumed for the purpose of comparison that the oxygen consumed as given by this test will be practically the same as that obtained by the four-hour English tests on which the formulæ are based.

The results obtained in the Worcester experiments on the 10-ft. filter dosed with Imhoff tank effluent as obtained from the 1912 annual report, pages 54 and 55, are shown in detail in Table 4 accompanying.

TABLE 4.

WORCESTER EXPERIMENTAL FILTERS. 1912 REPORT. RECEIVING IMHOFF TANK EFFLUENT. FILTER EFFLUENT TESTED AFTER 2.3 HOURS' SETTLEMENT.

(All data in parts per 100 000)

	Filter No. G.	Filter No. H.
Depth of stone, feet	10	10
Size of stone, inches	$\frac{1}{2}$–$1\frac{1}{2}$	$\frac{3}{4}$–$2\frac{1}{2}$
Rate of dosing, m.g.d. acre	1.553	1.563
Rate of dosing, gals. per cu. yd. per day	96	97
Influent: Free ammonia	2.43	2.43
Albuminoid ammonia	.67	.67
Residual organic nitrogen	1.067	1.067
Oxygen consumed	11.90	11.90
Strength	93.7	93.7
Effluent: Free ammonia	1.78	1.85
Albuminoid ammonia	.23	.25
Residual organic nitrogen	.28	.30
Nitrates	.60	.51
Strength	7.9	7.6
Reduction of strength	85.8	86.1
Purification units, per cu. yd. per day	8 200	8 350

Turning now to the Lawrence tests, here again the writer refers to the original data in the absence of being able to identify Mr. Eddy's records. In the year 1908 Annual Report of the Massachusetts State Board of Health, page 370 and following, is given a summary of the previous ten years' tests of various

filters, and of these, Nos. 135, 136, 247, 248 and 222 are reported in some detail. Table No. 5, following, gives the tabulation of the data reported in this 1908 report and tabulations of the purification unit.

TABLE 5.

LAWRENCE EXPERIMENTAL FILTERS. 1908 REPORT, PP. 370 ET SEQ.
(All data in parts per 100 000.)

Filter No.	135	136	247	248	222
Period of trials	9 yrs. 1 mo.	9 yrs. 1 mo.	4 yrs. 3 mos.	4 yrs. 4 mos.	5 yrs. 5 mos.
Depth, feet	10.0	10.0	5.0	8.0	8.0
Size of stone, inches	$\frac{1}{4}$–1	$\frac{1}{4}$–1	$\frac{1}{4}$–1	$\frac{1}{4}$–1	....
Rate of dosing, m.g.d. acre	1.512	1.797	1.465	1.490	1.394
Rate of dosing, gals. per cu. yd. per day	94	112	182	116	108
Influent: Free ammonia	4.70	4.59	4.33	4.41	3.52
Kjedahl nitrogen	1.04	.98	1.14	1.20	1.19
Oxygen consumed (2 minutes)	3.64	3.56	4.17	4.29	3.43
Strength	45.7	44.5	48.3	49.7	40.7
Effluent: Free ammonia	1.63	1.99	2.86	2.34	2.72
Kjedahl nitrogen	.40	.48	.97	1.03	.57
Nitrates	2.55	2.21	.612	1.77	.45
Strength	.25	2.9	13.14	8.0	11.35
Reduction of strength	45.5	41.6	35.2	41.7	29.3
Purification units per cu. yd. per day	4 280	4 660	6 400	4 830	3 160

It is to be noted that here, too, there is given no record of the volatile matter in the suspended solids, and the strength of the filter effluent is, therefore, calculated while ignoring this question of the volatile suspended solids.

Coming now to the experimental filters at Baltimore, as reported by the Baltimore Sewerage Commission in the 1911 annual report, which tests formed the basis of the writer's original paper, we get Tables 6 and 7, taken from pages 55 and 57 of this 1911 report. The rates of filtration are not given in the original report beyond the intimation that they were uniform for the various depths of filters, and the statement that the average rate was approximately 3.3 million gallons per acre of filter surface per day. For the purpose of making these Tables 6 and 7 and to simplify comparison, the writer has assumed a

uniform rate of one million gallons per acre per day, and the resulting figures for purification are no doubt somewhat less than that actually obtained.

Examined in the way outlined above, some of the tests made, such as the Gloversville test and the Baltimore test, seem to indicate very definitely a greater purification effected per cubic yard of stone by the shallow filters. The Worcester tests do not lead to any conclusion, because of the varying conditions under which the various tests were made. The Lawrence earlier tests seem to show that there is no notable difference in the output of the filters of various depths. In comparing these tests, however, it should be noted that the Gloversville and Baltimore tests do report the amount of volatile suspended solids in the filter effluent, and that these are properly accounted for in the formula and in the purification thus obtained. Neither the Worcester nor the Lawrence test report these volatile suspended solids, and therefore no allowance is made in figuring purification units.

It is well known that some part of the settling solids in the effluent of coarse grain sprinkling filters is putrescible.

TABLE 6.

Baltimore Experimental Filters. 1911 Report of Baltimore Sewerage Commission, Table B, Page 55.

Depth of filter, feet	6	9	12
Size of stone, inches	1–2	1–2	1–2
Rate of dosing, m.g.d. acre, *assume*	1.0	1.0	1.0
Rate of dosing, gals. per cu. yd. per day	104	69	51
Influent: Free ammonia, ppm	19	19	19
Organic nitrogen, ppm	16	16	16
Oxygen consumed, ppm	50	50	50
Strength, pp. 100 000	47.3	47.3	47.3
Effluent: Free ammonia, ppm	15	11	9
Organic nitrogen, ppm	12	10	10
Nitrates, ppm	8	15	18
Volatile suspended solids, ppm	50	33	27
Strength, pp. 100 000	18.4	10.7	7.6
Reduction of strength	28.9	36.6	39.7
Purification units per cu. yd. per day	3 000	2 500	2 030

TABLE 7.

BALTIMORE EXPERIMENTAL FILTERS. 1911 ANNUAL REPORT, TABLE D, PAGE 57.

Depth of filter, feet	4.5	7.5	10.5
Size of stone, inches	1–2	1–2	1–2
Rate of dosing, assumed, gals. cu. yd. per day	138	83	59
Influent: Free ammonia, ppm.	18	18	18
Organic nitrogen, ppm.	10	10	10
Oxygen consumed, ppm.	42	42	42
Strength, pp. 100 000	38.5	38.5	38.5
Effluent: Free ammonia, ppm.	16	11	7
Organic nitrogen, ppm.	8	8	7
Nitrates, ppm.	3	11	17
Volatile suspended solids, ppm.	36	27	24
Strength, pp. 100 000	15.8	9.7	5.6
Reduction of strength	22.7	28.8	32.9
Purification units per cu. yd. per day	3 130	2 400	1 940

CONSTRUCTION FACTORS.

If it is true that in the treatment of a given sewage its stability or non-putrescible condition is brought about in sprinkling filters of varying depths to the same extent per cubic yard of material in the bed, there is no doubt about deeper beds being cheaper than shallower ones; this is stated by the writer in his book on "Sewage Disposal," page 703. On that assumption, the deeper beds would undoubtedly be cheaper if we were sure that surface clogging, as experienced at Reading, would not increase the operating costs and if we were also certain that high nitrification, comparatively speaking, is worth securing in addition to reducing the organic matter to a point where the effluent will not putrefy.

Mr. Eddy's point that the distributing system is more likely to vary in proportion to the area of the filter than with the quantity delivered has an element of truth, in that the cost of the distribution system will depend on both of these factors, although we have made no detailed comparisons for the approximate studies hitherto undertaken. There are rather striking differences in the unit costs of floors, false bottoms, walls, galleries and distributors, between Mr. Eddy's figures based on

his Fitchburg prices and those used by the writer in his original paper. Local factors of design and market prices are no doubt abundantly capable of explaining these differences. The higher these unit costs are for the filter floor, the greater will be the benefit of deeper filters, comparatively speaking.

As to the writer's unit prices for the structures above mentioned, there is nothing that can be added except that they are in accordance with his repeated experiences. Eliminating the item of filtering material (broken stone), his unit prices are in accordance with the results of the recent letting at Plainfield, N. J., and substantially conform to the prices obtained in 1913 at Baltimore, Md.; at Reading, Pa.; and Columbus, Ohio; and Atlanta, Ga.

As to broken stone, the Fitchburg pıice of $1.95 per cubic yard is no doubt more representative of New England conditions than the $1.50 price used by the writer. The low price was used by the writer with the intent of making the comparison fair to the deep filters, as the lower the price of broken stone, the less is the possible advantage which might accrue to the shallower filters.

It is perhaps worth while to point out that excavation, embankments and some minor appurtenances are not included in the figures for the writer's sprinkling filter costs. The total cost of an installation, including all factors not varying with the depth, will be markedly higher than the base prices given.

Vol. II FEBRUARY, 1915 No. 2

BOSTON SOCIETY OF CIVIL ENGINEERS
FOUNDED 1848

PAPERS AND DISCUSSIONS

TOILET REGULATIONS FOR INDUSTRIAL ESTABLISHMENTS. REPORT OF COMMITTEE.

BOSTON, November 3, 1914.

MR. BERTRAM BREWER, CHAIRMAN SANITARY SECTION,
BOSTON SOCIETY OF CIVIL ENGINEERS:

Sir, — Pursuant to instructions, the committee appointed by you to consider the regulations for toilet facilities in industrial establishments, a subject now under consideration by the State Board of Labor and Industries, has completed its study and submits the following

REPORT.

The committee visited the Bureau of Labor and Industries and received from its sanitary engineer copies of a draft of proposed regulations and other contributory data.

In order to prepare itself to criticise the proposed regulations intelligently, your committee visited several industrial establishments employing workers of various nationalities with widely differing personal habits. It has also held several meetings to discuss the questions involved; it has investigated the laws and regulations of other states and the practice of certain large corporations; and it has consulted the available literature bearing upon the problem and several engineers who have special knowledge in the premises.

Your committee finds that the regulations proposed by the State Board of Labor and Industries are generally fitting and proper and not burdensome to the employer of labor. Furthermore, they should afford sufficient protection to the employee. On the other hand, your committee has suggested certain changes in the text of the regulations in the interest of clearness and consistency.

Because the condition in which toilet rooms are maintained may depend in large measure upon the ideals of certain employees, and as ideals of proper cleanliness and care differ widely among different classes of employees, there appears to be no way of obtaining proper conditions except through a system of state inspection and supervision, supported by adequate police power.

At the present time the manufacturers of the state are complaining of too many inspections and that the very frequent admission of inspectors, both those authorized by the state and those representing private associations, interferes in no small degree with the work of the various establishments. This annoyance should be reduced to the minimum consistent with the health and welfare of the employees; and if the state factory inspection could be made by one board, even though it requires more than one kind of inspection, conflict of authority might be avoided and the manufacturers relieved of some of the annoyance of which they complain.

The proposed regulations, with the changes suggested by the committee, are transmitted with this report.

Respectfully submitted,

Robert Spurr Weston,
George A. Carpenter,
Richard A. Hale,
Committee.

Toilet Regulations for Industrial Establishments Recommended by the Sanitary Section of the Boston Society of Civil Engineers.

(Adopted December 9, 1914.)

TOILET FACILITIES.

I.

Where Required and Sex Designation.

In every establishment where persons are employed, there shall be provided within reasonable access a sufficient number of proper water-closets, earth closets or privies, and wherever ten or more persons of both sexes are employed together, separate water-closet compartments or toilet rooms shall be provided for each sex, and shall be plainly so designated.

No person shall be allowed to use a closet or privy which is designated for the use of persons of the opposite sex.

II.

Number Required.

The number of seats shall not be less than one to every twenty-five (25) males and one to every twenty-five (25) females, based upon the maximum number of persons, of either sex, employed at any one time, except that where urinals are provided, the number of seats required may be decreased by one for each urinal installed; but the total number of seats, however, shall not be less than two thirds the number required above.

III.

Location.

Water-closets and urinals must be readily accessible to the persons using them. In no case may a closet be located more than one floor above or below or more than 300 ft. distant from the regular place of work of the person using the same.

In tenant factories, mercantile or office buildings, the owner shall provide separate toilets within reasonable access, as above defined, for the common use of the tenants.

IV.

Privacy.

(*a*) *Existing Installations.*

The entrance to every water-closet compartment, which opens directly into a room, hall or passageway in a building where both sexes are employed, or room, hall or passageway frequented by both sexes, shall be screened by a screen or vestibule at least six (6) feet in height.

(*b*) *Future Installations.*

Every water-closet compartment hereafter installed shall be located in a toilet room, or shall be built with a vestibule to screen the interior from view.

(*c*) *All Installations.*

Where separate toilets for each sex adjoin, they shall be separated by solid partitions, and the entrances shall be as remote as possible. They shall not open into a common ante-room.

V.

Ventilation.

(*a*) *Existing Installations.*

Every water-closet compartment, excepting as hereinafter provided, shall be ventilated directly to the outside air by a window, skylight or other suitable opening.

All water-closets which are not ventilated directly to the outside air by a window, skylight or other opening shall be entirely enclosed in a compartment or toilet room, by either extending the side walls to the ceiling or by independently ceiling them over at a minimum height of eight (8) feet. This compartment or toilet room shall then be ventilated by either:

1. An exhaust system; or

2. A stack to the roof at least 6 in. in diameter.

Wherever practicable, these toilets shall be relocated so that they will be exposed directly to the outside light and air, in accordance with the requirements for new installations.

(*b*) *Future Installations.*

Every water-closet compartment hereafter constructed shall be ventilated directly to the outside air by a window, skylight or other suitable opening. Where the water-closet compartments ventilate into an air shaft, the area of such shaft in square feet must not be less than 20 per cent. of the height of the shaft in feet. If this air shaft is covered with a skylight, the net area of the openings at the top must be at least one and one-half times the area required for the shaft.

VI.

Lighting.

(*b*) *Future Installations.*

The minimum amount of window space for every toilet room in which one urinal or seat is hereafter installed shall be four (4) square feet, and for each additional urinal or seat one (1) square foot additional window space shall be provided.

(*c*) *All Installations.*

All windows must be so constructed that they can be readily opened to at least one half their total area.

Every toilet room or water-closet compartment shall be so lighted that all parts of the room or compartment are easily visible at all times during working hours. If daylight is not sufficient for this purpose, artificial illumination shall be maintained.

VII.

Size of Toilet Room.

In all water-closet compartments hereafter constructed, there shall be at least ten (10) square feet of floor space and 80 cubic feet of air space per urinal or seat installed.

VIII.

Type of Water-Closet.

All water-closets shall be provided with ample water for flushing.

All water-closets hereafter installed shall have individual bowls made of porcelain or vitreous earthenware; they shall be provided with seats made of wood or other non-heat-absorbing material, which shall be coated with varnish or some other waterproof substance.

All future installations of water-closets in inside rooms shall be provided with local seat vents connected with a stack or chimney having an area of cross section of not less than three (3) square inches per closet.

IX.

Enclosing Woodwork.

(*a*) *Existing Installations.*

All woodwork enclosing the bowl of the closet shall be removed and the space within the compartments shall be painted with some light-colored non-absorbent paint.

(*b*) *Future Installations.*

The bowl of the closet shall be free and clear so that the space behind and below may be readily cleaned.

X.

Partitions and Walls.

(*b*) *Future Installations.*

Hereafter, when more than one water-closet is installed in a toilet room, partitions shall be provided between the seats. These may be of wood if covered with paint or some other non-absorbent material. They shall be not less than six (6) feet high, and, where practicable, shall not extend nearer the ceiling or floor than one foot. They shall be at least twenty-eight inches (28 in.) apart.

(*c*) *All Installations.*

The enclosing walls shall be substantially constructed and

designed to secure privacy. All outside walls, unless constructed of glazed tile, brick, etc., shall be kept well painted with a light-colored non-absorbent paint, varnish or other impervious compound.

XI.

Floors.

(*b*) *Future Installations.*

The floor of every water-closet compartment or toilet room hereafter installed, and the side walls, to a height of nine (9) inches, shall be constructed of material impervious to moisture, and which has a smooth surface.

(*c*) *All Installations.*

The floors of all water-closet compartments and toilet rooms shall be kept in good repair, and free from large cracks or holes.

XII.

Doors.

(*b*) *Future Installations.*

All water-closet compartments hereafter installed in men's toilet rooms shall be provided with doors at least three (3) feet in height and they shall be set twenty-four (24) inches above the floor.

(*c*) *All Installations.*

All water-closet compartments inside a toilet room used by females shall be provided with a door at least forty-two (42) inches high and furnished with a suitable fastener.

XIII.

Urinals.

(*b*) *Future Installations.*

Hereafter wherever urinals are installed, the floors in front for a distance of at least twenty-four (24) inches shall slope to the drain.

The use of the iron trough type is prohibited, and all urinals

shall be made of impervious non-corrosive materials, shall be individual, and preferably of the wall or vertical slab type.

(*c*) *All Installations.*

Where more than ten (10) males are employed a urinal shall be provided; urinals shall be provided in the ratio of one urinal to every forty (40) males, based upon the maximum number of persons employed at any one time. Two (2) feet of wall urinal shall be considered as an equivalent of one urinal.

The floors shall be constructed of impervious material to at least twenty-four (24) inches distant.

XIV.

Heating.

(*b*) *Future Installations.*

In all water-closets hereafter installed, the heating facilities shall be so arranged as to permit a thorough cleaning of the floors and walls.

(*c*) *All Installations.*

It is recommended that all water-closet compartments and toilet rooms shall be kept heated during the working hours to at least fifty (50) degrees Fahrenheit.

XV.

Miscellaneous.

Where practicable, an adequate supply of toilet paper shall be provided in every water-closet compartment.

Any indecent pictures or words shall be removed from the walls or partitions of the toilet rooms.

XVI.

Maintenance.

All toilets and urinals shall be kept clean. Regular and thorough cleansing shall be practiced. Disinfection alone is not to be relied upon. In every establishment there shall be one person who shall have direct charge of and be held responsible for the cleanliness of all sanitary appliances installed.

WASHING FACILITIES.

I.

Where Required and Sex Designation.

In every establishment where persons are employed there shall be provided, within reasonable access, a sufficient number of proper washing facilities, and where ten or more males and ten or more females are employed together, separate washing facilities shall be provided for each sex, and shall be plainly so designated.

II.

Number Required.

The number of wash bowls, sinks or other appliances shall not be less than one to every thirty (30) persons, based upon the maximum number of persons using the same at any one time. Twenty (20) inches of sink will be considered as an equivalent of one wash bowl.

In special industries or departments where there is undue exposure to poisonous substances or liquids, or where the work is especially dirty, one may be required for every five (5) persons, and in these cases they shall be provided with clean, running hot and cold water.

III.

Location.

The washing facilities provided must be within reasonable access as above defined for toilets, and at least one wash bowl, sink or other suitable appliance shall be provided in or adjacent to every toilet room.

IV.

Lighting.

All washing facilities shall be clearly lighted at all times during working hours.

V.

Cleanliness.

All washing facilities or appliances and the floors in and around the same shall be kept clean, and regular and thorough cleansing shall be practiced.

VI.

Miscellaneous.

Where common sinks are provided, these shall be furnished with individual wash basins. One tap for each 20 in. of wall sink, or one pair of taps for each 20 in. of double sink, each supplied with clean running water, shall be provided with the sinks.

In the above regulations, no specific rules are given for privies. There are few industrial establishments in Massachusetts which are not provided with running water, and most of the establishments where connection with sewers is not possible could arrange to drain sanitary fixtures into cesspools or suitable independent sewage disposal plants. Where privies are unavoidable, they should under no circumstances communicate directly with any work-room, but should be separated by a vestibule open to light and air. Such other regulations for closets as are pertinent should be applied to privies.

It is recommended that all privies be screened to prevent the access of flies and other insects to the dejecta, which latter should be received in a water-tight receptacle and removed at frequent intervals; in other words, the so-called "bucket system" should be used. The so-called water-tight privy vaults, if used alone, are not considered satisfactory.

Where the bucket system is used, it is recommended that dry earth or sand be supplied in each privy, and that if possible the dejecta be disinfected to prevent the spread of infection.

While the fixtures and plumbing are important from a public health standpoint, the paramount requirements are an abundance of air and light, with privacy and cleanliness.

Cleanliness is the most important factor. As a general rule,

it is true that the most modern toilet facilities, when neglected, are far less satisfactory than older and cruder fixtures, well cared for.

A dark toilet compartment is usually a dirty one; therefore, toilet rooms and compartments should be well lighted.

Closets without local vents generally produce disagreeable odors, and therefore seat ventilation is recommended, especially where closets are not directly exposed to outside light and air. If the seats be ventilated and the requirements for cleanliness, light and privacy be met, there appears to be no reason why closets in existing inside rooms should not be permitted.

Harrison P. Eddy,
President, Boston Society of Civil Engineers,
1914 – 1915.

Vol. II MARCH, 1915 No. 3

BOSTON SOCIETY OF CIVIL ENGINEERS
FOUNDED 1848

PROCEEDINGS

SIXTY-SEVENTH ANNUAL MEETING.

THE annual meeting of the Boston Society of Civil Engineers will be held at the Boston City Club, corner of Somerset Street and Ashburton Place, Boston, on Wednesday, March 17, 1915.

As previously announced, the annual meeting this year will consist of three principal features: a business meeting at noon, the annual dinner in the afternoon, and the smoker in the evening.

Business Meeting. — The annual meeting required by the Constitution will be called to order at 12 o'clock M. in the Assembly Room on the third floor of the new Club House.

Business. — Announcement of the election of new members.

To receive the annual reports of the Board of Government, of the Treasurer and of the Secretary.

To receive the annual reports of the several special committees.

To reappoint the several special committees.

Announcement of the result of letter-ballot for officers for the ensuing year.

Presentation of the Desmond FitzGerald Medal.

Address of the retiring President.

Annual Dinner. — The thirty-third annual dinner will be served at half past one o'clock P.M., in the main banquet hall or auditorium on the fourth floor of the new Club House.

At three o'clock Mr. Frederic H. Newell, consulting engineer of the United States Reclamation Service, will give an

illustrated lecture on water storage, particularly as applied to irrigation and water power in the West.

Smoker. — The usual informal smoker will be held in the evening, beginning at seven o'clock, in the main banquet hall.

S. E. TINKHAM, *Secretary.*

PAPERS IN THIS NUMBER.

"Insurance for Engineers." Nathan H. Daniels.

(Presented January 27, 1915.)

Discussion of "The Hydro-Electric Power Plant at the Wachusett Dam."

Discussion of "The Commission-Manager Form of Government."

Memoirs of Deceased Members.

CURRENT DISCUSSIONS.

Paper.	Author.	Published.	Discussion Closes.
"Commission-Manager Government."	H. M. Waite.	Jan.	March 15.
"Economic Depth of Trickling Filters."	H. P. Eddy.	Feb.	April 15.
"Depth of Filtering Material."	H. W. Clark.	Feb.	April 15.

MINUTES OF MEETINGS.

BOSTON, February 17, 1915. — A regular meeting of the Boston Society of Civil Engineers was held this evening at Chipman Hall, Tremont Temple, and was called to order at 8 o'clock by the President, Harrison P. Eddy. There were present 105 members and guests.

By vote the reading of the records of the meetings held January 13 and January 27, 1915, was dispensed with, and they were approved as printed in the February JOURNAL.

The Secretary reported for the Board of Government that it had elected the following to membership in the grades named:

Members — Arthur Benson Appleton, William Joseph Buckley, Fayette Samuel Curtis, Everett Frank Dowst, Gilbert Munday Harris, Carl Perry Hubbard, Arthur Caswell King, John Robert Nichols, Frederick Dexter Smith and Merton Rogers Sumner.

Associate — Wallace Brainard Conant.

Juniors — Martin Warren Cowles and Charles Loring Hall.

Mr. William S. Johnson then read the paper of the evening entitled, "Ground Water Supplies." The paper was fully illustrated by lantern slides.

In the discussion which followed the reading of the paper, the following took part: Robert Spurr Weston, Allen Hazen, Henry A. Symonds.

S. E. Tinkham, *Secretary*.

Sanitary Section.

Boston, Mass., February 3, 1915.—A meeting of the Sanitary Section of the Boston Society of Civil Engineers was held this evening in the library of the Society, Tremont Temple. The meeting assembled at 8 o'clock with the Chairman presiding.

The Chairman appointed the following special committee to study and report upon "Methods of Design and Construction and Results of Operation of Inverted Siphons for Carrying Sewage Only and for Storm Water": Wm. S. Johnson, Chairman; R. M. Whittet, Dwight Porter.

The Chairman also appointed the following committee to nominate officers of the Section for the coming year: Frank A. Barbour, Chairman; Frank B. Sanborn, Edward Wright, Jr.

The first speaker of the evening was Dr. Frederic Bonnet, Jr., professor of chemistry, Worcester Polytechnic Institute, who spoke on the subject, "Garbage Disposal at Worcester, Mass." Dr. Bonnet described in a most interesting manner the methods used in feeding garbage to hogs, and the steps necessary

to prevent odors and to preserve sanitary conditions on the farm. He also spoke of the methods used to prevent disease among the pigs. An excellent collection of lantern slides was used in illustration.

Mr. W. J. Springborn, manager of the New Bedford Extractor Company, gave a talk on "Garbage Reduction Plants," describing in particular the plants at Cleveland, Schenectady and New Bedford. The opaque projector was used to throw photographs on the screen and added considerably to the interest of the talk.

Mr. E. G. Whittemore, superintendent of the Springfield Merg Reduction Company, and a number of other gentlemen, took part in the discussion.

There were thirty present. On account of the severe storm, only a few of the out-of-town members were present. Meeting adjourned at 10.40 o'clock.

FRANK A. MARSTON, *Clerk.*

BOSTON, MASS., March 3, 1915.—The annual meeting of the Sanitary Section, Boston Society of Civil Engineers, was held this evening in the Society library, Tremont Temple.

Dinner was served at the Boston City Club at 6 o'clock, in one of the private dining rooms on the ninth floor. There were 36 present, and, as usual, the occasion was a very enjoyable one.

At the close of the dinner the Chairman surprised the Clerk in a most delightful way by presenting him, on behalf of the Section, with a gold watch charm and fob, as a token of appreciation of his services during the past four years. A large bouquet of roses was sent to Mrs. Marston with the compliments of the Section.

The Chairman then read a short paper dealing with the work of the Section, and the outlook for the future. Short addresses were also made by Harrison P. Eddy, President of the Society, and George C. Whipple, Past-Chairman of the Section.

The business meeting was called to order by Chairman Bertram Brewer at 8.15 o'clock, in the Society library.

As there were no objections, the reading of the minutes of the February meeting were postponed and ordered printed in the JOURNAL.

The report of the Executive Committee for the past year was read by the Clerk. Voted to accept the report and place it on file.

The report of the nominating committee was presented by F. B. Sanborn. Voted to accept the report.

Voted that the polls be closed and that the Clerk be instructed to cast a ballot for the officers and members of the Executive Committee as nominated. The following were declared elected to serve for the ensuing year:

Chairman—Stephen DeM. Gage.

Vice-Chairman—Dr. Frederic Bonnet, Jr.

Clerk—Frank A. Marston.

Additional members of Executive Committee: Bertram Brewer, Hiram A. Miller, Austin L. Maddox.

The Chairman then presented Mr. David A. Hartwell, chief engineer of the Sewage Disposal Commission, Fitchburg, Mass., who read a very interesting paper on "The Sewage Disposal Works at Fitchburg, Mass." At the close of the paper, the speaker showed some seventy lantern slides, illustrating the various stages of the construction work and the details of the several structures.

The retiring Chairman then introduced the new Chairman of the Section, Mr. Stephen DeM. Gage, who spoke briefly in regard to the work of the Section.

The meeting adjourned at 9.45 o'clock. There were 61 present at the meeting.

FRANK A. MARSTON, *Clerk.*

APPLICATIONS FOR MEMBERSHIP.

[March 8, 1915.]

THE By-Laws provide that the Board of Government shall consider applications for membership with reference to the eligibility of each candidate for admission and shall determine the proper grade of membership to which he is entitled.

The Board must depend largely upon the members of the Society for the information which will enable it to arrive at a just conclusion. Every member is therefore urged to communicate promptly any facts in relation to the personal character or professional reputation and experience of the candidates which will assist the Board in its consideration. Communications relating to applicants are considered by the Board as strictly confidential.

The fact that applicants give the names of certain members as reference does not necessarily mean that such members endorse the candidate.

The Board of Government will not consider applications until the expiration of twenty (20) days from the date given.

ALLEN, JOHN EDWARDS, Worcester, Mass. (Age 22, b. Holyoke, Mass.) Senior at Worcester Polytechnic Inst., civil engineering course. Refers to C. M. Allen, Frederic Bonnet, Jr., A. W. French, H. C. Ives and A. J. Knight.

BRACKETT, LEROY GILE, Somerville, Mass. (Age 23, b. Biddeford, Me.) Graduate of Boston Y. M. C. A. Evening Polytechnic School, 1913, civil engineering course. From winter of 1911 to June, 1914, with Silverman Engineering Co. as rodman, transitman and draftsman; since that time has been with the N. Y., N. H. & H. R. R., first in the Construction Dept. and later in office of Division Engineer, under J. W. Pearson; has worked chiefly as draftsman. Refers to H. W. Bacon, C. B. Humphrey, C. H. Restall, W. J. Semple and A. S. Tuttle.

COBURN, RAYMOND WILLARD, Weston, Mass. (Age 28, b. Weston, Mass.) Graduate of Harvard College, 1910, degree of A.B.; spent last half-year in Graduate School of Applied Science; entire course followed civil engineering lines. From Aug., 1910, to Jan., 1911, resident engineer with Mass. Highway Comm.; from Jan. to Sept., 1911, with Middlesex County as transitman and assistant engineer; from Sept., 1911, to Jan., 1912, with Mass. Highway Comm.; from April to Oct., 1912, engineer for Town of Nahant on highway work; from Oct., 1912, to Jan., 1914, resident engineer for Mass. Highway Comm. in Dracut and Methuen; from Jan., 1914, to date, resident engineer for Mass. Highway Comm. in Swampscott. Refers to G. W. Cutting, Jr., A. W. Dean, H. J. Hughes, F. H. Kendall, J. J. Preble and A. E. Tarbell.

FOLEY, ERNEST LEON, West Newton, Mass. (Age 21, b. Waltham, Mass.) Graduate of Newton Technical High School; student in extension courses, University of Wisconsin, and in evening buildings course at Mass. Inst. of Technology. Practical experience covers period of nearly four years and includes work as draftsman and erection superintendent on various kinds of machinery. Refers to H. W. Haywood, H. B. Johnson and W. H. Lawrence.

GAMMAGE, ARTHUR L., Everett, Mass. (Age 30, b. Woonsocket, R. I.)

Graduate of Worcester Polytechnic Inst., 1907. From Oct., 1907, to March, 1911, assistant chemist for Connecticut State Board of Health; from March, 1911, to date, chemist for Robert Spurr Weston, consulting engineer, Boston, Mass. Refers to F. P. Bonnet, Jr., H. P. Eddy, F. A. Marston, G. A. Sampson, E. C. Sherman and R. S. Weston.

Gaudreau, Lucien Ernest Damien, South Braintree, Mass. (Age 27, b. New Bedford, Mass.) Received technical education from I. C. S., course in mining engineering, 1908, and course in theory and design of steel and concrete at Franklin Union, 1912. From Sept., 1909, to Oct., 1910, chainman and rodman on irrigation projects with Arnold Engineering Co. of Chicago, at Denver, Colo.; from Oct., 1910, to date, with N. Y., N. H. & H. R. R. Co., Boston, first as rodman in Maintenance of Way Dept., later as inspector and finally as transitman. Refers to Isaac Rich, H. L. Ripley, G. T. Sampson, A. S. Tuttle and H. L. White.

Greene, Francis Ingraham, Newport, R. I. (Age 32, b. Newport, R. I.) Graduate of Brown University, degree of B.S. in civil engineering, 1906. From July, 1906, to Dec., 1911, with O. Perry Sarle, civil engineer, Providence, R. I.; from Dec., 1911, to date, with U. S. Engineer Department; is now Junior Engineer with that department. Refers to A. S. Ackerman, A. H. Blanchard, H. B. Drowne and A. J. Ober.

Miller, James Mark Reavely, Roxbury, Mass. (Age 37, b. Galashields, County of Selkirk, Scotland.) Graduate of Edinburgh Normal School, 1892; student for five years in engineering classes of Boston Y. M. C. A. evening school, American School of Correspondence, etc. During year 1901 with sugar mill company in Porto Rico on erection of machinery and buildings; from 1902 to 1904 with General Electric Co., Lynn and Schenectady, on detail and design of special machinery and buildings; 1905, with Kindl & Glaffey, consulting engineers, on general office work, inspection and reports; 1906, with Westinghouse, Church, Kerr & Co., on structural steel design and details; also with W. S. Barstow Co., New York, N. Y.; 1908 with city engineer of San Francisco on inspection of reinforced concrete cisterns; 1907, with Associated Oil Co. of California on remodeling of plant; from 1909 to 1910, with D. H. Burnham Co., Chicago, on structural steel design and detail; from 1912 to 1913, with Interstate Commerce Commission; 1914, with city architect of Cleveland, O., on designing and supervision of all his engineering work; 1915, designing structural steel for architects and industrial corporations. Refers to C. M. Spofford.

Newsom, Reeves Jose, Swampscott, Mass. (Age 21, b. Columbus, Ind.) Graduate of Purdue University, 1913; one year's graduate work at Mass. Inst. of Technology, 1913–14. Since June, 1914, has been in the office of city engineer, Lynn, Mass., on water supply work. Refers to H. K. Barrows, C. B. Breed, R. H. Sutherland and W. L. Vennard.

Sarle, Oliver Perry, Providence, R. I. (Age 52, b. Warwick, R. I.) Began practice of engineering with J. Herbert Shedd, 1886; since that date has been employed chiefly on hydraulic and sanitary work; has had experience on about forty dams and over fifty water-works plants; recently built

sewage disposal works for Central Falls, R. I., and is now designing for Warwick, R. I., water-works plant which will involve expenditure of more than a half-million dollars. Refers to W. D. Bulloc, G. A. Carpenter, O. F. Clapp, J. W. Ellis, A. T. Safford and F. E. Waterman.

Taylor, Philip W., Fitchburg, Mass. (Age 26, b. Arlington, Mass.) Graduate of Mass. Inst. of Technology, 1910, civil engineering course. From June to Oct., 1910, transitman with C. C. C. & St. L. R. R.; from Oct., 1910, to June, 1911, transitman with B. & M. R. R.; from June, 1911, to Sept., 1912, transitman with Sewage Disposal Commission, Fitchburg, Mass.; from Sept., 1912, to date, assistant engineer with Sewage Disposal Commission, Fitchburg, in charge of designs and office work. Refers to H. P. Eddy, D. A. Hartwell, F. A. Marston, Dwight Porter, J. P. Snow and C. M. Spofford.

LIST OF MEMBERS.

ADDITIONS.

Alden, Frederick T. . . . . 109 Porter St., Malden, Mass.
Baker, Lloyd E. . . . . 51 Congress Ave., Providence, R. I.
Brown, Walter K . . . . 227 Rawson Road, Brookline Mass.
Carr, Joseph L. . . . . 91 Bellingham St., Chelsea, Mass.
Conant, Wallace B. . . . . Concord, Mass.
Curtis, Fayette S. . . . . 7 Revere St., Jamaica Plain, Mass.
Dalton, Marshall B. . . . . 12 Newbury St., Boston, Mass.
Davis, Harold F. . . . . 441 Main St., Reading, Mass.
DeMerritt, Robert E. . . . . 119 Haven St., Reading, Mass.
Dingman, Charles F. . . . . Palmer, Mass.
Dowst, Everett F. . . . . Concord, N. H.
Durgin, Clyde M. . . . . 21 Ashfield St., Roslindale, Mass.
Eberhard, Walter C. . . . . 138 Poplar St., Roslindale, Mass.
Eddy, Harrison P., Jr. . . . . 65 Gray Cliff Road, Newton Centre, Mass.
Edgar, Charles L. . . . . 70 State St., Boston, Mass.
Farwell, Robert B. . . . . 15 Beacon St., Boston, Mass.
Flett, Louis E. . . . . 154 Youle St., Melrose, Mass.
Gallene, Victor J. . . . . Y. M. C. A., Fall River, Mass.
Gladding, Raymond D. . . . . 1049 Beacon St., Brookline, Mass.
Hakes, Jesse F. . . . . 37 W. Preston St., Baltimore, Md.
Hanna, John B. . . . . 273 Middle St., Pawtucket, R. I.
Hubbard, Carl P. . . . . 26 Vernon St., Woburn, Mass.
Ives, Howard C. . . . . Worcester Polytechnic Inst., Worcester, Mass.
Knight, Arthur J. . . . . Worcester Polytechnic Inst., Worcester, Mass.
Knowlton, Arthur W. . . . . St. Johnsbury, Vt.
Nichols, John R. . . . . 82 Avon Hill St., Cambridge, Mass.
O'Brien, James A. . . . . 100 Bloomingdale St., Chelsea, Mass.

Patton, Eugene S. . . . . 166 Mulberry St., Pawtucket, R. I.
Pinkham, Millard B. . . . . 172 Walnut Ave., Roxbury, Mass.
Preble, Frank L. . . . . 14 Beacon St., Boston, Mass.
Smith, Frederick D. . . . . 25 Waverley St., Malden, Mass.
Thayer, Burdett C. . . . . Clinton, Mass.
Thomas, Howard C. . . . . 200 Washington St., Wellesley Hills, Mass.
Tosi, Joseph A. . . . . 15 Harvard St., Worcester, Mass.
Wales, Withrop L. . . . . 11 Danville St., West Roxbury, Mass.
Worcester, Robert J. H. . . . . 5 Stow St., Concord, Mass.

CHANGES OF ADDRESS.

Beach, Theodore M. . . . . 111 Bowles St., Springfield, Mass.
Bessey, Roy F. . . . . 273 Martense St., Brooklyn, N. Y.
Bryer, Charles S. . . . . 313 Hunnewell St., Needham Heights, Mass.
Carter, Frank H. . . . . 284 Lincoln Ave., Cliftondale, Mass.
Carter, Harold L. . . . . 281 Tappan St., Brookline, Mass.
Chamberlin, George E. . . . . 15th St. and Western Ave., Chicago, Ill.
Coffin, S. P. . . . . 135 Harvard St., Medford, Mass.
Dalton, Thomas V. . . . . 16 Ridgemont St., Allston, Mass.
Dashper, Frederick C. . . . . 835 Hyde St., San Francisco, Cal.
Ellis, Lester F. . . . . 493 Commercial St., Portland, Me.
Fogg, Benjamin G. . . . . Maine St., West Newbury, Mass.
Foster, Willard M. . . . . Shrewsbury, Mass.
Gartland, Edward V. . . . . 71 Topliff St., Dorchester, Mass.
Gerrish, Herbert T. . . . . 172 Condor St., East Boston, Mass.
Hale, Robert S. . . . . 939 Boylston St., Boston, Mass.
Hathaway, Erwin O. . . . . Nashua, N. H.
Hosmer, George L. . . . . Mass. Inst. of Technology, Boston, Mass.
Kidd, Alexander L. . . . . 501 City Hall Annex, Boston, Mass.
Lee, Edward G. . . . . 11 Lisbon St., Lewiston, Me.
Link, John W. . . . . 208 S. La Salle St., Suite 1900, Chicago, Ill.
Lochridge, Elbert E. . . . . Box 1238, Springfield, Mass.
Macksey, Henry V. . . . . Supt. of Public Works, Woburn, Mass.
Miller, William L. . . . . 171 Alford St., Boston, Mass.
Morse, Charles F. . . . . 215 Clinton St., Watertown, N. Y.
Robinson, Harold L. . . . . 27 Winthrop St., Winchester, Mass.
Sargent, Albert F. . . . . 423 Main St., Malden, Mass.
Saville, Thorndike . . . . . Wilder Laboratory, Hanover, N. H.
Starr, John A. . . . . 31 Brighton Ave., Allston, Mass.
Storrs, Harry A. . . . . 720 South 6th Ave., Tucson, Ariz.
Tannatt, Willard C., Jr. . . . . Town Hall, Easthampton, Mass.
Whipple, George C. . . . . 6 Berkeley Place, Cambridge, Mass.
Wiley, Walter T. . . . . 703 City Hall Annex, Boston, Mass.

EMPLOYMENT BUREAU.

The Board of Government maintains an employment bureau for the Society, to be a medium for securing positions for its members and applicants for membership, and also for furnishing employees to members and other desiring men capable of filling responsible positions.

At the Society room two lists are kept on file, one of *positions available* and the other of *men available*, giving in each case detailed information in relation thereto.

Men Available.

290. Age 31. Student for two years at Mass. Inst. of Technology. Has had eight years' experience in drawing, including five years on mechanical and three on civil engineering work; has had experience on location and valuation field work for railroads and on structural steel and concrete work. Salary desired, $20 per week.

291. Age 24. Received technical education at Mass. Inst. of Technology, civil engineering course, class of 1913. Has had one year's experience in drafting and inspecting for cotton mill. Salary desired, $3 per day.

292. Age 27. Graduate of Mass. Inst. of Technology, 1909, degree of S.B. in civil engineering. Has had one year's experience in surveying with Comm. of Mass.; two years as assistant in civil engineering at Mass. Inst. of Technology; six months as assistant superintendent with Aberthaw Construction Co.; one year as hydraulic engineer, U. S. F. S., on stream gaging; six months as structural steel draftsman; two years as designing engineer on reinforced concrete; six months as superintendent on construction of water and sewerage plant. Desires designing or executive engineering work, preferably in office; salary to be commensurate with work.

293. Age 40. Special student at Mass. Inst. of Technology for three years. Has had over twelve years' experience with various engineering firms and architects in Boston and vicinity: experience includes all classes of construction drafting and writing of construction specifications; has had charge of men. Salary desired, $25 per week.

294. Age 27. Graduate of Tufts College, 1914, with degree of B.S. in civil engineering. Has had one summer's experience as rodman for city engineer and four months' experience as draftsman and detailer on reinforced concrete work with Stone & Webster Engrg. Corp. Desires field or office work in civil or structural engineering. Salary desired, $60 per month.

295. Age 26. Graduate of Mass. Inst. of Technology. Has had three months' experience as transitman for city engineer, Beverly; three months as inspector on sewer construction for city engineer, Malden; two and a half months on water system installation at Duxbury; two months on New York

State Barge Canal as junior assistant engineer. Desires position as transitman, inspector or assistant engineer. Salary desired, $18 per week.

296. Age 34. Received technical education at Mechanic Arts High School, Boston, and from one year's study in technical courses at Franklin Union. Has had one year's experience as rodman for Met. Park Comm.; three years as transitman on surveys and construction of electric roads; one year as instrumentman with Charles River Basin Comm.; three and one-half years as topographic draftsman, Bureau of Engineering, Borough of Richmond, New York City; three years on municipal and private work for Geo. A. Smith, town engineer, Norwood, Mass.; one year with Stone & Webster as draftsman and inspector on new Technology buildings. Desires position with contractor or town engineer.

LIBRARY NOTES.

Recent Additions to the Library.

U. S. Government Reports.

Annual Report of Director of Geological Survey for 1913–14.

Deep Well at Charleston, South Carolina. Lloyd William Stephenson.

Geology and Oil Prospects of Northwestern Oregon. Chester W. Washburne.

Geology of Hanagita-Bremner Region, Alaska. Fred H. Moffit.

Glacier National Park. Marius R. Campbell.

Gold, Silver, Copper, Lead and Zinc in Arizona in 1913. V. C. Heikes.

Gold, Silver, Copper, Lead and Zinc in Colorado in 1913. Charles W. Henderson.

Gold, Silver, Copper, Lead and Zinc in Montana in 1913. V. C. Heikes.

Publications by Survey Authors on Metals and Non-Metals except Fuels. Isabel P. Evans, Ed.

Rochester Mining District, Nevada. Frank C. Schrader.

Rutile Deposits of Eastern United States. Thomas L. Watson.

Results of Spirit Leveling in Nebraska, 1896 to 1913 inclusive. R. B. Marshall.

Results of Spirit Leveling in Wisconsin, 1897 to 1913 inclusive. R. B. Marshall.

Water-Supply Papers 331 and 335.

State Reports.

Louisiana. Cotton Warehouses and Terminal at New Orleans. Ford, Bacon & Davis.

Massachusetts. Annual Report of State Board of Health for 1913.

County Reports.

Essex County, Mass. Engineer's Report for 1914.

Municipal Reports.

Boston, Mass. Building Law.

London, England. Abstract of Accounts, Metropolitan Water Board, for 1913–14.

Minneapolis, Minn. Annual Reports of Registrar of Water Works for 1903, 1910 and 1913.

North Adams, Mass. Annual Report of Department of Public Works for 1914.

Miscellaneous.

Aborigines of South America. G. E. Church. Gift of Clemens Herschel.

Engineering Index for 1914.

Institution of Civil Engineers (London). Minutes of Proceedings, Vol. CXCVII.

Industrial Arts Index for 1914.

Leonardo da Vinci. Richard Muther.

Leonardo da Vinci's Note-books. Edward McCurdy, Tr.

Leonard de Vinci. Gabriel Seailles.

Leonardo der Techniker und Erfinder. Franz M. Feldhaus.

(The) Miracle Man. Frank L. Packard.

Above five items gift of Clemens Herschel.

New International Encyclopædia, Vols. VII and VIII.

Vitruvius: The Ten Books on Architecture. Morris Hickey Morgan, Tr. Gift of Clemens Herschel.

LIBRARY COMMITTEE.

NEW ENGINEERING WORK.

(Under this head a brief description of new engineering work contemplated or under construction will be presented each month. Engineers and contractors are requested to send descriptions of their work to the Secretary, 715 Tremont Temple, Boston, before 1st of each month.)

Commonwealth of Massachusetts. — DIRECTORS OF THE PORT OF BOSTON. — Hydraulic dredge *Tampa* at work in reserved channel placing dredged material inside bulkheads of proposed piers near dry-dock site.

Boston Transit Commission. — *Dorchester Tunnel.* — The work on Sections D and E was described in the February issue of the JOURNAL.

Work will soon commence on the construction of Section H, located in Dorchester Ave. between Old Colony Ave. and Woodward St., and about 2 200 ft. long. The structure is to be mainly of reinforced concrete, and consists of a double-track tunnel to be built by the cut-and-cover method. The work also includes a pump well, an emergency exit and sewer changes.

City of Boston. — PUBLIC WORKS DEPARTMENT, HIGHWAY DIVISION, PAVING SERVICE. — Work is in progress on the following streets:

Deering Road,	Blue Hill Ave. to Harvard St.	Bituminous macadam.
Spring St.,	Gardner St. to Webster St.	Bituminous macadam.
Seaver St.,	Humboldt Ave. to Walnut Ave.	Excavating and grading.
Seaver St.,	Humboldt Ave. to Blue Hill Ave.	Excavating and grading.
Temple St.,	Spring St. to Ivory St.	Excavating and grading.
East First St.,	Across water passageway.	Building sea wall.

PUBLIC WORKS DEPARTMENT, SEWER AND WATER DIVISION, SEWER SERVICE. — The following work is in progress:

Beach St., between Atlantic Ave. and Harrison Ave., replacing wooden sewer with one of reinforced concrete.

Union Park St., sewage pumping station; installing motors.

Milton St. (Hyde Park), sewage ejector pumping station; completed but not in commission.

Dorchester Brook sewer, rebuilding between Brook Ave.

Place and Brookford St., Dorchester, large concrete surface drain and 12 in. and 15 in. pipe sanitary sewers in same trench.

Davenport Brook concrete conduit, Adams and Minot Sts., Dorchester.

Dent Street Brook conduit, West Roxbury, in private land; Pleasant and Lagrange Sts., circular concrete conduit.

Faneuil Valley Brook conduit in Faneuil and Oakland Sts., between Newcastle Road and Bennett St., Brighton; large circular concrete conduit and 12-in. pipe sanitary sewer.

The Fore River Shipbuilding Co., Quincy, Mass., has the following work in progress:

U. S. Battleship *Nevada*.

Nineteen U. S. submarine boats.

U. S. Torpedo Boat Destroyers *Cushing*, *Tucker*, *No. 63* and *No. 64*.

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BOSTON SOCIETY OF CIVIL ENGINEERS
FOUNDED 1848

PAPERS AND DISCUSSIONS

INSURANCE AS AN AID TO ENGINEERS.

By Nathan H. Daniels, M.Am.I.E.E.

(Presented January 27, 1915.)

It is always a pleasure for an engineer to share his experience with his fellows, particularly if his work has been somewhat out of the ordinary. For a number of years I have had to do with the insurance of a large number of electric companies, under such circumstances that it has been necessary to study insurance problems from all points of view. While the work has taken in all branches, I shall speak only of fire insurance tonight, as this is the largest and most representative class; but the same general ideas will apply to the other classes.

It has frequently been necessary for me to examine plans for new construction or for alteration of existing buildings to see if the fire hazards have been reduced to a minimum. One would naturally expect the engineer who designs a building to be quite familiar with all elements which endanger it, and of these fire is one of the greatest, but I have not found this to be the case. It is not the engineer who designs the property, but the insurance companies who pay the losses on it, who have studied the subject and have developed standards of construction.

Note. Discussion of this paper is invited, to be received by Edward C. Sherman, Editor, 6 Beacon Street, Boston, before May 15, 1915, for publication in a subsequent number of the Journal.

The information which the insurance companies have accumulated on this subject has been of the greatest assistance to me in my work, and it is a real pleasure to come here to-night and tell you of some ways in which I have found insurance an aid to engineers.

Nearly every property is liable to damage by fire. The disaster may come at any time, and may be so large as to seriously disturb the finances of the company. By carrying insurance, an annual payment is substituted for this menace, a certainty is substituted for an uncertainty, and this condition conduces to greater business stability. Were it not for insurance, many large engineering enterprises would be financial impossibilities. They usually require large amounts of borrowed capital, and this cannot be obtained on attractive terms unless satisfactory security is offered, hence the mortgage covering the property usually requires that a reasonable amount of insurance shall be carried. Insurance is even more important for the protection of stockholders, as they own only the equity above the mortgage, and must suffer a total loss before the borrowed capital suffers as a result of any misfortune.

Insurance is based on the law of averages, and, as few business concerns own a sufficient number of risks of similar nature to create an average record, a pooling of the risks of many owners becomes necessary. One of the functions of an insurance company is to combine the experience of a large number of risks and to distribute the fire loss equitably among its policy holders.

Fire insurance rates are determined primarily from the loss records, just as life rates are determined from the mortality tables. If all fire risks were of a single type, such as dwelling-houses, the rates could be reduced to as simple formulæ as life rates; but with modern business there are countless classifications, each with its distinct hazards. Even within a single group, such as electric-power stations, the possibility of fire in the individual risks will vary between wide limits, depending on the construction and conditions of operation.

To determine correctly the insurance rate on any given plant, it is necessary that we know the general record of that class of risk, and also that we assign values to any special hazards

that may be present in the particular property. Work along these lines by the insurance companies' engineers has resulted in a scientific development of rating schedules for different classes of risks. These generally start with a certain base rate which represents the cost of insurance on a standard property of the class in question in which the hazards are minimized, and to this base rate charges are added for any deficiencies in or departures from the requirements set forth for the standard property.

These rating schedules are of great benefit to a person designing a new building or contemplating changes in an old one, for they indicate the most desirable types of construction from the standpoint of fire danger, while the amount of hazard which will be added if various deficiencies are allowed to creep in is shown by the added charges.

Under the schedule for rating electric-power stations which is very generally used outside of New England, a fireproof station absolutely standard in construction and occupancy takes a rate of 7c. per $100 of insurance for building and non-electrical contents, and 12c. for electrical contents. If the building has unprotected metal columns supporting roof or floors, 1c. is added to the above base figures; if wood skylights, 2c. for the first and 1c. for each additional, with a maximum charge of 7c.; if joisted wood floors, 10c.; if combustible finish leaving concealed space in walls, 3c.; if oil transformers, unless in fireproof rooms, 3c.; if lightning arresters are not standard, 2c.; if wood lockers, 2c.; if gasoline is stored in building, 15c.; if nearest fire hydrant is over 500 ft. distant, 5c.; if near another building, an exposure charge depending on the intervening distance, the construction of the building walls and the protection to openings in same. These are merely examples of a few of the charges but will suffice to indicate their scope and that insurance rates are determined by actual conditions of construction and occupancy found in each individual property.

To illustrate the range of insurance rates on electric-power station buildings, a standard building takes the base rate of 7c. above mentioned, while a frame shingle-roofed building with unprotected openings to basement, defective switchboard and wiring, careless housekeeping and no fire protection would take

a rate of $2.50 to $3.00 — or about forty times the rate on the standard station.

On first thought it would seem that the insurance companies would be anxious to write policies on the latter risk on account of the high rate, but the reverse is true and many companies would refuse to accept any insurance whatsoever on the high rated risk.

Each additional 10c. in the insurance rate of a one-hundred-thousand-dollar power station means $100 annually in insurance premium, or 5 per cent. interest on an investment of $2 000. Of even more importance is the increase in danger from fire and the possible interruption of service which it may cause. This can be considered roughly as proportional to the fire insurance rate, or forty times as great in the poorer station above mentioned as in the standard station.

Such analysis of risks is of much assistance in guiding future construction, but the insurance companies have gone further and devoted a great deal of study to methods of reducing fire dangers by better types of construction and safer appliances, which information is gladly furnished without charge to all persons interested.

Much of this work is done by the National Board of Fire Underwriters, an organization which is supported by the insurance companies, with its headquarters at 123 William Street, New York City. The National Board works along many lines, but that portion of its work which particularly interests us to-night is the study which it makes of many common fire dangers and of means for controlling or extinguishing fires, with a view to developing methods of construction or types of apparatus which will minimize the possible damage.

These investigations of the National Board are often made at the suggestion of other organizations interested in the subject, notably the National Fire Protection Association, of which I shall say more later. In this work the National Board endeavors to consider all elements of design, cost and use which enter into the problem, and consults freely with representatives of organizations interested in the particular subject under consideration.

It also maintains at Chicago a subsidiary organization, the

Underwriters' Laboratories, Incorporated, which, as its name indicates, maintains extensive laboratories equipped to make all tests necessary in connection with the work of the National Board, this including tests on raw materials and methods of manufacture, as well as on the finished product.

The results of the investigations are published by the National Board and are known as the National Board Rules for Standard Construction, which are a recognized authority in the matters to which they relate. One set of these Rules, with which many of you are probably familiar, is the National Electric Code for electric wiring and installation of electrical apparatus. This prescribes standard requirements for electric wiring and apparatus, and standard methods for its installation, and is prepared by the National Board and the National Fire Protection Association in consultation with representatives of the National Electric Light Association and manufacturers of electrical supplies. The National Board has made careful studies in many other lines, and has published pamphlets covering the construction and installation of fire doors, hose houses, gas and gasoline engines, moving-picture machines, acetylene-gas machines, coal-gas producers, automatic-sprinkler installations, etc. As an example of the wide scope of its investigations, I may mention that it has even produced a pamphlet on the construction and installation of incubators and brooders.

The National Board Rules often specify in considerable detail the materials to be used and the methods of manufacture for producing standard apparatus. It is often difficult, if not impossible, for an inexperienced person to determine whether a particular article complies with the standard requirements, and it is often difficult for an expert to determine the question without destroying the article. This is clearly shown in the case of a fire door. To meet the National Board standard, a fire door must be built of three layers of clear non-resinous wood, put together in a certain way and fastened with wrought-iron nails carefully clinched. This body is then covered with tin of a given weight, the joints being locked in a prescribed manner. It is evidently impossible for any one to examine a finished door and determine whether it is standard, for even if the tin covering appears to

be of the proper weight and properly applied, one cannot determine, without destroying the door, whether the core is of white pine or similar wood properly put together. In the absence of proof of standard manufacture, an insurance company might be unwilling to give full credit for such a door located at an important point.

To meet this difficulty, the Underwriters' Laboratories developed what is known as their labeled service about ten years ago. By this arrangement any manufacturer who is desirous of having any of his product known as fully meeting the requirements of the National Board Rules can arrange to have representatives of the Underwriters' Laboratories visit his property and follow the materials and the process of manufacture, and if it is found that the requirements have been fully met and the product is in every way standard, a label is attached to the finished article stating that it has been inspected and approved by the Underwriters' Laboratories. You will find this label on a great variety of apparatus, including fire doors, fire extinguishers, fusible links, fire retarding paint, etc. Its presence on any article is a guaranty that the product has been inspected during manufacture and that it fully meets the requirements of the National Board Rules. It fully answers any question as to the ability of the article to perform the service expected of it.

I am sorry to say that some engineers do not appreciate the advantages of using labeled apparatus. The cost of labeled service is only a small fraction of the selling price of the finished article, hence it often happens that the lower price at which an unlabeled article can be purchased is obtained at the sacrifice of quality. At one time I was inclined to question the advisability of using labeled apparatus myself, but in the light of longer experience I believe that it should be used whenever possible, since it is the best guaranty one can have of standard quality.

Any reference to the work which the insurance companies have done toward improving standards and disseminating information regarding the best forms of construction will be incomplete if I do not refer to the Factory Mutual Companies, as they are commonly called, who were really the pioneers in this work. These companies were started over fifty years ago, at a

time when the stock insurance companies did not give the same careful study to the estimation of fire hazards and the development of rates which they do to-day. Many mill owners felt that they were being charged excessive rates for insurance on their property, so a number of them formed an association for the purpose of carrying their own insurance. To reduce the cost, they began a careful study of fires in their own and other properties, to ascertain the most frequent causes of fire, and then studied the means of eliminating or reducing these causes. Almost from inception, they adopted a policy of declining to insure any risk which did not come up to their standard. They developed improved types of construction, and refused to take new members into their association, or to continue old ones, unless their properties conformed to these standards. As new standards of fire protection were developed, these too were required. This policy has been consistently maintained up to the present time, so that the term "a Mutual risk" means that the property is of the best type of construction and well protected against fire. The Mutuals have confined their activities almost entirely to factories, storehouses and electric-power stations. Where the building is of combustible construction or contains any considerable amount of combustible material, they usually require complete protection by automatic sprinklers.

The method which the Mutuals follow in determining the cost of insurance also differs from that of the stock companies. It is the policy of the Mutuals to make a high initial charge for insurance, and to return, at the end of the policy period, such portion of the premium as has not been used in paying losses, administration charges, etc., in the form of a dividend. A plant may pay an initial rate of 1 per cent., that is, \$1 for each \$100 of insurance, and at the end of the year get back 85c., making the net cost 15c., to which we will perhaps be justified in adding interest on the 85c. which the insurance company has been allowed to use for the year, which at 5 per cent. will amount to $4\frac{1}{2}$c., making the total cost of insurance $19\frac{1}{2}$c. for the year. It is evident that the cost of Mutual insurance will vary, depending on the amount of losses which the companies sustain in any given year. The stock companies, on the other hand, have adopted

the policy of making but one charge for the insurance, which is paid at the beginning of the policy period. The stock companies make a profit or loss on their underwriting according as their losses are greater or less than was anticipated.

The stock insurance companies have formed still other organizations, for the purpose of handling what we may call the commercial side of their business; that is, the making of rates, prescribing forms of policies and writing insurance. The body having such matters in charge for this city is the Boston Board of Fire Underwriters, at 55 Kilby Street, while for the rest of New England matters are handled by the New England Insurance Exchange, at 141 Milk Street. Attached to each of these bodies are engineers who are familiar with the work and studies which have been made along the lines of fire prevention, and who will gladly furnish advice regarding these matters and copies of the National Board Rules, etc., to any engineer or property owner who applies directly or through his insurance representative. The Mutual Companies are equally ready to assist in matters relating to risks such as they handle, and their representatives can be found at 31 Milk Street, Boston. I have always found these organizations glad to render all possible assistance in matters within their province.

Another organization which is a great help to those who wish to keep in touch with the subject is the National Fire Protection Association, whose headquarters are at 87 Milk Street in this city. The Association was formed in 1896 to promote insurance and improve the methods of fire protection and prevention. The majority of the underwriters' associations of this country, as well as many engineering and other societies, are among its active members. Any individual who is interested can become a member by paying a nominal annual fee. The Association holds frequent meetings, it publishes a magazine four times a year containing a great deal of information regarding work along lines of fire prevention, as well as giving details of many interesting fires which have occurred. Should there be a large fire of general interest, a special pamphlet describing it is sent to the members. The Association coöperates very closely with the National Board of Fire Underwriters in the preparation and revision of the

National Board Rules, much of the work being done by committees of the Association, whose reports are later adopted by the National Board. The National Fire Protection Association keeps its members in touch with progress along the lines of fire protection and prevention, exactly as your own Society keeps you in touch with the progress in your chosen line of engineering. I know of no better way of keeping in touch with the subject of fire prevention than by membership in the N. F. P. A.

I believe that engineers who are confronted with problems involving the element of fire hazard can get real help by consulting freely with the insurance engineers in regard to that phase of the work. This should result in a lessening of the danger of a disastrous fire, and this usually means a real money saving by a reduction in the cost of fire insurance. It is, of course, desirable that sketches and plans be submitted to the insurance interests at as early a stage of the work as possible, for any changes which they suggest can be absorbed much more easily before the work has well started. I have known of several cases where the failure to consider the matter of fire protection in the original laying out of water supplies and building plans has either greatly impaired the efficiency of the fire protection or has added unnecessarily to its cost. In a recent case which came to my attention, some two months were spent in preparing a set of sprinkler plans for a large group of buildings. The work was done with more than ordinary care yet a careful study of the plans showed that certain changes were necessary in the arrangement of piping. It then developed that the building had been erected and holes had been left to take the pipes as shown in the plans. Because of the rearrangement it was necessary to fill many of the holes which had been left and to drill others, which as you know is a rather costly procedure in a reinforced concrete building. This trouble would have been avoided had sketches been submitted before the work had progressed so far.

During the remainder of the evening, I am going to take up some elements which enter into the design of buildings which are intended to minimize the fire hazard. Our ideas of such buildings have changed greatly during the last twenty-five years. It was felt at one time that a building which was constructed entirely

of material which would not burn could properly be called fireproof, and presented no fire hazard. We now know that this is but a small part of the problem, and that if a non-combustible building is filled with inflammable contents it resembles a stove with a fire ready to light. The contents will burn if once ignited, and the stove may be seriously damaged if the fire becomes hot enough. The recent destruction of the plant of Thomas A. Edison is a striking example of what fire can do in supposedly fireproof buildings.

In fireproof construction it is well to avoid those materials which are liable to be damaged by heat even if they do not burn themselves. A brick wall is usually to be preferred to one of hollow tile if likely to be exposed to a bad fire, for, while neither will burn, the tile wall may be so badly cracked and broken that it will have to be replaced, while the brick wall would come through practically undamaged. In planning the fireproofing for important steel members, consideration must be given to the possibility of mechanical damage to the fireproofing. Under ordinary conditions 2 in. of cement may afford sufficient insulation to prevent the distortion of important steel beams, but if exposed to a bad fire it is quite possible that this thickness would break or spall quite badly, leaving the steel exposed. For important beams, 4 in. of concrete, well reinforced with wire mesh, is very much better. Similarly, in fireproofing vertical columns, consideration must be given to the possibility of mechanical damage. In a storehouse the fireproofing should be well protected on the outside, to prevent damage from passing hand trucks.

One method of reducing fire damage is to establish strong physical barriers to confine the incipient fire so it cannot assume large proportions. This can be done by dividing a building into sections by means of fire walls. Such walls, as their name implies, are sufficiently heavy to prevent a fire on one side from reaching the other. It is evidently necessary for a fire wall to be absolutely continuous, that is, we can allow no unprotected openings through it; hence, if at any time it becomes necessary to cut holes to allow the passage of pipes or electric wires or other devices, these openings should be carefully sealed up again that

the wall may be as strong as before. The necessity of such procedure is self-evident. Openings not only defeat the purpose of the wall, but firemen, believing that the wall is solid, may fail to notice a tongue of flame which comes through a small hole until the fire has started on the supposedly safe side of the wall.

It frequently happens, however, that it is necessary to maintain passages through fire walls, and in this case it is necessary to provide a covering which will be as nearly as possible equivalent to that of the wall itself. Such protection is afforded by a pair of standard fire doors, one on either side of the wall. These doors should be carefully fitted and should be absolutely standard in every respect. In other words, they should be labeled fire doors, put up with labeled hardware in accordance with the Rules of the National Board of Fire Underwriters. A pair of fire doors so installed have on many occasions shown themselves fully equal to a brick fire wall, and have held back very bad fires for several hours.

Care should be taken to see that there are no timbers running through the wall, and, if the roof on both sides is of combustible material, the wall should be carried up from three to five feet above the roof to prevent the fire jumping over. Of course, if the roof is not of combustible material, say a cement roof, the need of a parapet disappears.

Of equal if not greater importance is the closing of vertical openings, for the tendency of a fire is to work upward whenever possible. The great danger of stairways, elevator wells and similar vertical openings has been very clearly demonstrated in certain of the apartment-house fires which have occurred in this city during the last year. The danger can be reduced by installing hatches which are normally held open in such a way that they will drop in case of fire to close the opening in the floor and thus prevent an upward draft. Such a method is difficult to follow, however, and the better practice is to place stairways and shafts for passenger and freight elevators, dumb waiters, etc., in fireproof enclosures, all openings to which are closed with fire-resisting doors. A very excellent example of what can be accomplished in this direction is the Hotel Belmont in New York, and it would be worth the time of any of you who have occasion

to stop there to examine the very excellent manner in which fire cut-offs have been introduced.

A stair tower, separated fire wise from the building, has long been recognized as a means of getting people out of the upper stories safely in case of fire. To make this secure, however, it is necessary that all openings into the tower be closed with fire doors, so that people can safely pass floors on which the fire is raging. Not long since, I inspected such a tower in a large hotel. It was of very excellent construction, but every one of the eleven doors opening into it was a light wooden door, tinned only on the inside, which would have yielded after a few minutes exposure so that the tower would serve as a chimney to carry the fire to all the upper floors.

In considering fire protection, considerable thought must be given to the protection against fire occurring in neighboring buildings. This evidently calls for fire-resisting coverings to all openings in the building under consideration. Wire glass set in metal sash affords excellent protection, but has been known to melt out after very severe exposure. For very heavy exposures it should be reinforced with tin-clad shutters which may be closed every night or which may be released by fusible links in the event of the exposure from outside buildings. There is always the possibility of exposure by flames from fire on the lower floors of the building rising on the outside and entering the upper floors. Where there is danger of such exposure, it is well to install wire glass in metal sash, which will ordinarily afford such protection as is required.

When it is expected that an addition will be made to a building in the near future, it is sometimes desirable to make the end of temporary construction such as wood or corrugated iron. Such a temporary end will serve well for a time if it is not likely to be exposed to a bad fire, but if there is any considerable amount of combustible material in the neighborhood a more substantial construction should be used, for a comparatively small fire will completely destroy the end and probably do serious damage to the interior of the structure. I have in mind a large power station which was built with the expectation that it would be enlarged from time to time, so one end was corrugated iron

on a light wood frame. As the station was otherwise of excellent construction, I was much surprised to find a considerable addition to the charge for insurance because of the temporary end. Investigation showed that this charge was made not because of the temporary end itself but because a large wooden platform had been constructed on the outside of the station and was being used for the storage of a great variety of materials. A small house for the storage of oils had also been built on the platform, and as there was more or less leakage that portion of the woodwork had become thoroughly oil soaked. This was, of course, a very serious menace to the station, for a slight fire on the platform would have very quickly destroyed the temporary end, leaving the interior exposed to the flames. Had the rating schedule been strictly applied to this property, the additional cost of fire insurance because of this combination of temporary end and wooden platform would have been very nearly four hundred dollars a year. The station was improved by removing a considerable portion of the combustible storage and the installation of an unusually good supply of fire-fighting apparatus, with the result that the added charge was dropped to approximately one hundred dollars a year, and later was again cut in half.

It often happens that some particular section in a building presents a much greater fire hazard than the rest. Evidently this menaces the entire structure, hence it is often advisable to isolate the hazardous section by a standard fire cut-off, or, if possible, to remove the menace so that the property will take the same insurance rate. A case of this sort which comes to me was an addition to an existing power station. The addition was to be of the very best fireproof construction, but the old portion had a wooden floor, which added materially to the cost of insurance. It was desired to have large openings between the two sections to facilitate operation. Evidently a fire in the old section might do considerable damage in the new, hence the insurance rate for the new section would be considerably higher because of the wooden floor in the old section. This situation was handled by replacing the wooden floor with a concrete floor, making the two risks substantially identical and obtaining a low rate for each.

If a fire has once started, the problem is then to detect and to extinguish it. Of course, the most certain means of detecting fire is for some one to see it, hence it is customary, where considerable values are involved, to employ watchmen who make periodic rounds of the property whenever it is not in operation, to see that all is well. They are often on the lookout for burglars or trespassers, but for our purposes we will consider them only as a protection against fire. The property covered by a watchman is usually provided with a number of clock stations which he is required to visit in turn, at each of which he makes a permanent record of his call. In locating such stations, it is, of course, very desirable to so place them that the man will have to pass through or within sight of all parts of the property.

There are various automatic alarms which depend on the influence of heat for their action, and which are used with considerable success to give warning of an unusual rise in temperature.

It is well to provide some means of extinguishing small fires, say with 3-gal. chemical or Pyrene extinguishers, but if the property is located within the reach of an efficient and regularly organized fire department, it is questionable how far the property is justified in going in providing its own protection. Serious fires have occasionally developed because of failure to call the public department until after the private fire brigade had proved inadequate. There is no question, however, that a large property, or one which is at some distance from the regular department, should equip itself with a good water supply and a good supply of fire hose, nozzles, etc., and it can profitably organize a fire brigade of its own. If this is done, a great deal of time and effort must be put in training the members of the brigade that they will know exactly what to do in case of emergency. There is no time after a fire has started to teach lessons or to try experiments.

One of the best and most efficient means which has yet been devised for detecting and extinguishing a fire is the automatic sprinkler system, with which I presume you are all familiar. With this system, pipes carrying water under pressure are run along the ceilings and are equipped at suitable intervals with orifices sealed with plugs held in place by readily fusible metal. A fire

will, of course, cause a rapid rise in temperature and the heat reaching the fusible link will melt it out, allowing the water to flow and extinguish the fire. Some object to this system because the water will continue to flow until it is shut off. The possibility of such damage can be minimized by the use of an alarm valve, a device which is placed in the supply pipe and which sounds an alarm whenever water flows, thus giving warning of fire and water damage. It is generally felt that the water from the sprinkler heads will probably do less damage than if the fire had been allowed to continue until it was detected and extinguished in the ordinary way. Every serious fire that occurs brings forcibly to the public the benefit of the automatic sprinkler system, and I believe the time is not far distant when it will be required much more generally than at present.

Objection is sometimes made to the precautions I have outlined on the ground that the building will contain no combustible material. Experience has shown that this condition is almost impossible of attainment and, even if we can attain it for the moment, we have no assurance that it can be maintained indefinitely. If the present occupancy does not involve the storage of combustibles, a new tenant may come in whose stock can burn. There is nothing more awkward than to have a fire break out when you have no means of extinguishing it, and for this reason every structure should be designed with the idea that it may at some time contain some combustible material which may get on fire.

There is always a possibility that at some time a part of the space will be used for storage purposes and that this will contain combustible material. I recall visiting a small substation of an electric light and power company which was entirely fireproof and which normally contained no combustible material save a small amount of waste used for wiping and cleaning about the machines, and a barrel of lubricating oil. The waste was stored in standard waste cans and the oil in a standard cabinet. The chance of fire damage was very small indeed. On a later visit, however, I found that a portion of the floor where it had been planned to place an additional machine had been given over to the storage of supplies of another department and was piled with

boxes and crates. Some of the boxes contained fragile articles packed in excelsior. Some of these had been opened, the contents removed and the excelsior left exposed. Of course, this storage was not contemplated when the substation was laid out, but it did materially increase the fire hazard, particularly as the station was protected by only two 3-gal. chemical extinguishers and the nearest hydrant was about 500 ft. distant. Had a match been thrown into this pile, or had a fire from any other portion of the station been carried to it by a gust of wind, it would have been practically impossible to prevent a fire, which would have reached and softened the light steel trusses which supported the roof. The danger was greatly increased by several planks, which were used for a walk when snow was on the ground but which were now stored up among the roof trusses and would have added to the fire had it once started.

Somewhat later, another hazard was introduced in this same station owing to the burning out of an armature of one of the machines. In order to make repairs it was necessary to take the machine apart, and a good deal of wood was used in blocking up while repairs were in progress. Some repairs came packed in excelsior, and both packing cases and excelsior were allowed to lie around while repairs were going on. Furthermore, as the damage was to electric wiring, gasoline torches were used for soldering certain joints, and these naturally introduced further elements of danger, among these being the use of matches and gasoline and the presence of open flames. Fortunately no fire occurred. Normal operation has now been resumed, the combustible storage has been removed, the last machine is now in place, and the substation is once more a very excellent fire risk.

After the building is occupied care should be used to see that conditions do not arise which will make it easy for a fire to start. This, however, is largely a question of good housekeeping and does not ordinarily concern the designing engineer. Among the things which come under this head is the care of the electric wiring, not only to see that the original installation is in accordance with the National Code, but to see that extension cords and temporary connections are maintained in safe condition and not open to the possibilities of short circuit or overheating.

As you know, an electric current flowing through a resistance generates a considerable amount of heat, and there are cases on record where a twisted joint in temporary wiring has developed heat enough to set surrounding material on fire. Among other matters to be looked after are the prohibition of the storage of gasoline and similar material, and the use of gasoline torches and other appliances only when absolutely necessary; the careful storage of readily inflammable material such as waste, excelsior, papers, etc., in such places that they cannot be reached by a carelessly tossed match; the prompt collection of oily waste and its storage in standard waste cans until it can be removed, for we know that oily waste is very liable to spontaneous combustion. Collections of sweepings and other dirt should be at once removed, as they occasionally ignite spontaneously.

I have taken considerable time this evening to speak in a somewhat rambling way on the subject of fire dangers and fire protection. I believe it is a subject with which every engineer can profitably become somewhat familiar, for the laws governing fires and their control are simple and well known. We can no more trifle with fire than we can trifle with the force of gravity. If one link in our chain of fire protection is weak, a fire is certain to find it and the entire chain will break. The public has felt in the past that a bad fire was a misfortune for which no one was to blame. It has now learned that buildings can be constructed in which the danger to life and property by reason of fire will be greatly reduced. The feeling is growing that while a man may take chances with his own property or with things which affect no one but himself, he has no right to take risks which endanger the lives or the employment of others. I believe that before long the engineer or architect who designs a building which permits a repetition of recent disastrous fires will be judged as severely as he who designs a bridge that fails, a dam that goes out or a building that collapses. This changed feeling is well reflected in the following paragraph which recently appeared in the *Iron Age*, commenting on the Edison fire:

"The rapid spread of the fire and the general destruction of the plant were not due to mysterious causes. No accidental combination of circumstances, or weather conditions, or peculiar

hard luck, seems to have had anything to do with the magnitude of the disaster. If the plant could be reproduced to-day identically as it was before the fire, a similar small blaze starting at the same point would undoubtedly cause the whole affair to be repeated. Every one knows that the fact that concrete will not burn does not make every concrete building fireproof. The rules for constructing to prevent the spread of fire have been on record since long before the Edison fire. The lesson taught by this case is the old one of disobedience to known laws."

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PAPERS AND DISCUSSIONS

DISCUSSION OF THE HYDRO-ELECTRIC POWER PLANT AT THE WACHUSETT DAM, CLINTON, MASS.

By Frederic P. Stearns, Dexter Brackett, H. K. Barrows, W. L. Puffer, Charles M. Allen and Alfred O. Doane.

Mr. Frederic P. Stearns. — There is one thing which occurs to me in connection with this matter. Some twenty years ago, when the question of developing electric power at the Wachusett Dam was first broached, an engineer for whom I have very great respect, in discussing the question with me, said, " Don't do it. Such works are built at a great expense for water-supply purposes, and don't get mixed up with commercial work." That statement may have been made partly in jest and partly in earnest. I believe there are cases where it might be undesirable to develop the water power at a water-works dam, even though the proposition appeared to be a profitable one, by reason of the incidental troubles, political and otherwise, which might be caused thereby.

Under other circumstances, as, for instance, under the conditions prevailing at the Wachusett Dam, I believe it to be expedient to develop the power, both as a source of profit to the water works and on the ground that it is desirable to conserve available energy. Holding this view, at the time the dam was built, the gatehouse below the dam, which would have been necessary in any case, was designed of increased size and in such

a way that it might be available as a house in which to install a power plant.

While the work was under construction, the act of the legislature referred to in the paper made it inexpedient to proceed with the installation of the plant, because it made possible the taxation of a great amount of water-works property which would not have been taxable if the power plant were not built. It would have been possible, under that act, for the taxation to have exceeded the amount of money which could be earned by such a plant.

As a result of that legislation the additional expenditures for providing for the installation of power were unproductive for several years, but with the later legislation, which limited the taxation to practically the cost of installing the power plant, the work of installation was taken up and the works are now, as stated in the paper, in operation with successful results. The Metropolitan District is receiving a fair return from the sale of power and there is the gain to the community resulting from the conservation of energy which would otherwise have been wasted.

The paper gives me much more credit in connection with the power plant than is warranted. I am pleased, however, to have been connected even in a somewhat remote way with a plant which has been so successful, and those more directly connected with it are to be congratulated upon having made it so successful.

Mr. Dexter Brackett. — I can add little to what has already been stated in regard to this particular plant. I do, however, wish to testify that Mr. Frederic P. Stearns is very largely responsible for many of the details, especially those connected with the questions of water supply, which form an important portion of the whole.

Our ability to use, or to utilize in developing power, 98 per cent. of the total quantity of water which passes the dam is due in large measure to the very large storage capacity of the reservoirs, and our ability to draw water for use in the Metropolitan District from either the Wachusett or the Sudbury reservoir, which is below it, at such times as we can do so to the best advantage.

As an indication that the plant at Clinton has been successful it may be stated that the board has recently decided to install a similar plant in Southborough, in order to utilize the fall of the water flowing from the Sudbury reservoir into the Weston aqueduct, and into a reservoir located below the Sudbury Dam, and the project has developed so far that a contract has been made with the Edison Electric Illuminating Company, which has agreed to take for five years all the power which may be developed there. The plans for the plant are now being completed and it is expected that the works will be in operation before October, 1915.

The quantity of energy will be about one half of that developed at Clinton, and the net income probably somewhat less than that proportion, because the cost of operation will be larger in proportion.

The water wheels and generators at the plant at the Sudbury Dam are to be mounted vertically instead of horizontally, as at Clinton, the generators to be of the 3-phase, 60-cycle, alternating current type, generating current at 2 400 volts, which will be transformed to 13 200 volts before delivery to the Edison Company. Three vertical turbines directly connected to generators will be used, two of which will utilize the energy from a fall of about 35 ft. in the water flowing to the Weston Aqueduct, and the third that in a fall of about 60 ft. in the water flowing into Framingham Reservoir No. 3. The estimated cost of the plant is $80 000.

Mr. H. K. Barrows. — This is certainly a case of true conservation by the utilization of a by-product. The plant is primarily for purposes of water supply, and the water power is the by-product. It is interesting as the first example of the kind in this country, if not in the world.

The amount received for the power, I assume from the figures submitted, probably nets the Commonwealth somewhere between $15 000 and $20 000 a year after allowing for fixed annual charges on the power plant. Capitalizing with interest at 4 per cent. it seems like quite a large figure, perhaps four or five hundred thousand dollars. On the other hand, the cost of the entire plant, including dam and reservoir, was about

$11 000 000, for which the annual charges at, say, 5 per cent., would be about $550 000. The return from this power plant, while a fair-sized amount yearly, represents only a small portion of the yearly cost of the whole water supply plant. It is an amount, however, well worth saving.

Another thought occurs in this matter, and that is, To what extent can power development be carried out in other cases? The Metropolitan Water Board are planning a similar installation at one of their other dams, and considering the country as a whole no doubt this can also be done at other plants. It appears that they must of necessity be the large and expensive water supply developments like that for New York City and others of that type, because to develop an amount of power that is worth while requires a fairly large constant flow of water, along with the head which would normally be available at such a reservoir. In this case about 118 square miles of drainage area is utilized, or enough to provide a satisfactory amount of power with the available head of about 90 ft. In the case of water supply for cities and towns of lesser size, in some cases the head would be available, but in general the amount of water to be utilized would be small. This manner of power utilization must of necessity, therefore, be limited to the larger and more expensive water supply plants.

It would be of interest if Professor Allen would include in his discussion some of the curves and results of the tests which he made on these wheels. The specifications called for a test under a head of 90 ft., but it has not been stated what requirements, if any, were made for the performance of the wheels under a greater or less head. It appears that the range is from 80 to 100 ft., and it would be of interest to know what the performance of these wheels would be under this considerable variation in head. The wheels are of modern type in quite general use in the country as a whole. In this immediate vicinity, and in New England generally, there are but few installations as yet of this kind.

Progress in turbine development here in this country has made great strides during the last decade, and the delay in establishing the power plant at Clinton on account of legal

difficulties has at least resulted in a much better plant than could have been installed at the time the dam was constructed.

PROF. WILLIAM L. PUFFER. — I came here to-night as a listener, not having consulted my notebook or prepared anything in the way of looking up the past history of the subject, so that whatever I may say is entirely off-hand and without any consultation with the engineers of the Board.

Knowing as I did the general electrical demand and supply in the vicinity of the Wachusett Dam at the time I was first asked by Mr. Brackett to look into the question, it was self-evident to me that the proposition as it had been advanced up to the time I first knew of it was not a desirable one.

There appeared to be but three possible customers for the output of the proposed plant,— the Lancaster Mills, operating a 600-volt, 40-cycle plant; the Marlboro Electric Company, generating power at 2 300 volts, 60 cycles; and the Connecticut River Transmission Company, distributing 66 000-volt, 60-cycle power of the Connecticut River Power Company.

It so happened that I had tested and accepted the pair of large frequency changers at the Lancaster Mills, which had been designed in accordance with my specifications. These machines take the 13 000-volt, 60-cycle power from the high-tension lines and both reduce it to 575 volts and at the same time change the frequency to 40 cycles for use in the mills. In accordance with the desires of the owners, I had specified that the machines could be so operated as to offset the harmful effects on the transmission line due to the presence of a great many of the motors as used in the mill and about Marlboro.

The use of the frequency changers for this purpose rendered it unnecessary to consider in the design of the Metropolitan power plant anything in the nature either of line voltage regulation or the compensation of low-power factor. I was familiar with the output of the Marlboro Electric Company, which has a very heavy day load of motors of the induction type and also has a very large demand for lighting of the highest class, requiring good service.

The very first duty of mine was to convince the Board that it would be very undesirable to put in a 40-cycle plant, as that

frequency was practically a matter of history and that power could never be sold in the future to any customer than the Lancaster Mills, and that in all probability the Connecticut River Transmission Company would be the ultimate purchaser of the power to be developed. However, there was no trouble in gaining this point.

It was several times necessary to read the riot act both to the people who wanted to buy power and to those who wanted to sell water wheels and governors, because they could not understand the kind of service that would best match the demand for the water that the Metropolitan Board had to supply. No water-wheel manufacturer had apparently contemplated the installation of a water wheel and governor under such conditions that there must be a limit set to the maximum amount of water passing through the wheel, and that this limit must hold irrespective of any fluctuations of the mechanical output of the wheel.

The governor and gates must, when desired, be operating in the usual manner up to this limit, and there could be no such thing as a momentary increase in the maximum amount of water passing. In order that a definite known amount of water be flowing steadily requires that the gates be locked, as it were, at a proper opening, but should there be any accidental reduction of the output of the generator corresponding to this opening, the immediate increase in speed must be checked during the time that the output remains too small.

The limit of output of the plant as a whole is set by the sum of the various gate openings, which is limited and must be equal to the flowing capacity of the aqueduct. The electrical output at this maximum gate opening depends on the height of water in the reservoir.

In the planning of this plant it was known that there must be satisfactory operation at any or all times either with the Connecticut River Transmission Company's lines, or isolated operation with the Marlboro Electric Company or one of the frequency changers as a load or a combination of both. It was known that when the new plant would be operating there might also be power fed into the lines from turbines, gas-engine driven

generators and slow-speed steam engines, yet it was desired that all of the water passing should be efficiently used.

The method of operating should be about as follows: The generators are slowly brought up to the proper speed and voltage and when exactly in step with the line the switches are closed, and the generators are ready to supply "all of the energy that can be developed" from the quantity of water decided upon. The gates are gradually opened and adjusted, the increasing flow of water causes an increase in the torque, and so a balancing electrical output flows to the line, — no more, no less. The gates should be now "blocked" by some mechanical device or by a "steep falling characteristic" at exactly that definite output, yet have an overspeed safety device to move that gate should the load fall off.

As a safeguard, the wheels and generators were tested at an increase of 100 per cent. in speed, during which test the speed rose to 800 revolutions per minute and the voltage from 13 800 to 34 000.

Prof. Charles M. Allen. — At the time the wheels were installed in the hydro-electric station of the Metropolitan Water Works at Clinton, Mass., a brake test was made on one of the units. The generator was temporarily set aside and a special shaft with outboard bearing was installed, upon which was mounted the dynamometer. The dynamometer was so rigged by a system of overhead levers that the weight of the dynamometer was taken off the bearing during test.

The accompanying curves show the results of these tests. It will be noticed that the horse-power curves relative to speed for the various gate openings are flat. This is a good characteristic for wheels which are to operate under varying heads, as is the case in this plant.

Mr. Alfred O. Doane. — The subject has been covered very thoroughly and there is very little left for others to add to it.

There is one point, however, that occurred to me in connection with the plant. A comparatively long time passed after the dam was built before the plant was installed, and that time was not entirely wasted, because it so happened that it

TESTS NOS. 2313 TO 2358 INCL.

ALDEN ABSORPTION DYNAMOMETER

WORCESTER, MASS.

UNIT NO.

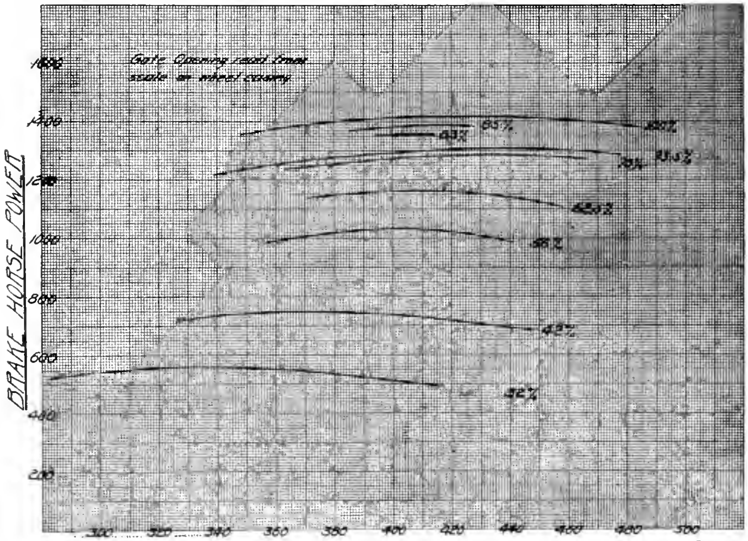
DATE Aug. 3-9, 1911

TEST OF L.H. 30" Special Smith Wheel Wheel MADE BY S. Morgan Smith Co

AT PLANT OF Met. Water & Sewerage Board

TESTS MADE FOR " "

REMARKS Curves showing relation betw. Horse Power and Speed for various Gate Openings under a head of 90'-0"



TESTS MADE BY C.M. Allen

TESTS NOS. 2313 TO 2350 INCL.

ALDEN ABSORPTION DYNAMOMETER

WORCESTER, MASS.

UNIT NO.

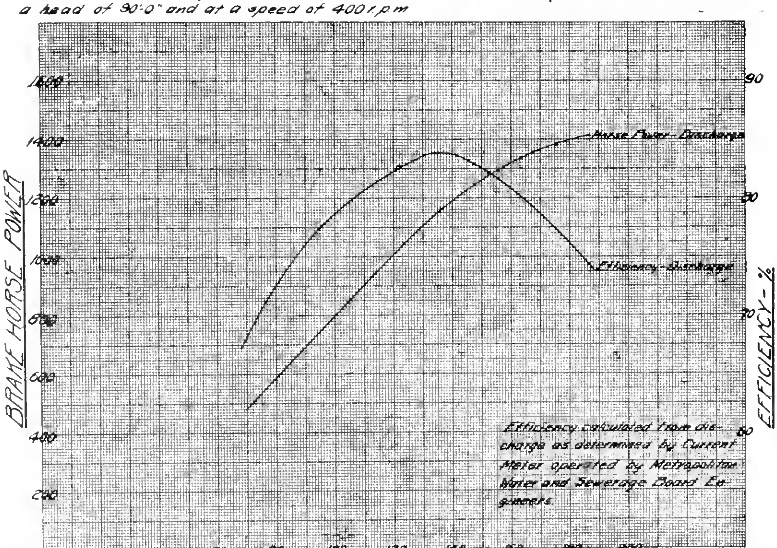
DATE Aug 3-9, 1911

TEST OF L.H. 30" Special Smith Wheel Wheel MADE BY S. Morgan Smith Co

AT PLANT OF Met. Water & Sewerage Board

TESTS MADE FOR " "

REMARKS Curves showing relation betw. Horse Power & Discharge (and Efficiency) under a head of 90'-0" and at a speed of 400 r.p.m.



TESTS MADE BY C.M. Allen

was about the time when there was very rapid development in the design of water wheels and of the electrical apparatus, so that the Clinton plant as finally installed was of a very different type and character, both on the hydraulic and electric ends, than if it had been put in directly after the dam was finished, and while that brought about some complications in the fitting of this style of plant to the power-house design, which was made up with the idea of the earlier apparatus, it was all a distinct gain because of the higher efficiency and more modern character of the apparatus. The machinery proposed for the Sudbury dam hydro-electric plant which has been spoken of is still further advanced in design, due to the great and increasing demands of hydro-electric propositions. The type of water wheel at the Sudbury dam is very different from that at Clinton. The ones that will probably be used at this place are vertical shaft machines of the so-called American type, which has been so much improved in the last two or three years that they now get Holyoke tests of 90 per cent. efficiency or better.

PROF. FRANK B. SANBORN. — It is not just clear to me what the coefficient of the Venturi meter was finally determined to be.

MR. ALLARDICE. — Owing to the very special type of Venturi meter, the standard formula for computing the flow did not apply, and at the time of the official test of the turbines the meters had not been calibrated. As the demands upon the new plant were urgent, it was decided to use a coefficient of 100 and make observations on a temporary dial on the recorder, which observations could be reduced to true values of flow after the meter had been calibrated. As the velocity of the water entering the scroll case of the turbine was also being measured with a pitometer, it soon became evident that a coefficient of 100 was too high. Therefore, a trial was made with the coefficient value 95, and observations made on the rates of flow. It was found, eventually, that the coefficient for this very special type of meter was a variable with a value of about 98 at the low flow measured, and gradually decreasing to $93\frac{1}{2}$ at the high flow.

PROF. GEORGE E. RUSSELL. — What was the reason for this very special design of meter, and was it rated before installation?

Mr. Allardice. — Obviously there were but two locations in the penstock lines where a Venturi meter could be installed. One place was in the 48-in. cast-iron pipe portion, and the other in the 84-in. vertical brick-lined well. The distance between the bottom of the vertical well and the lower sluice gate was too short for a 84-in. meter, and the high velocity of the water in the 48-in. cast-iron pipe, about 14 ft. per second, made it impractical to put a 48-in. meter in this portion of the line. Therefore the special design.

The meters were permanently installed and connected with their proper recorders before they were calibrated.

Professor Sanborn. — Is it true that the wheels were guaranteed to have an efficiency of 82 per cent., while as a matter of fact the official test resulted in an efficiency of $80\frac{1}{2}$ per cent.?

Mr. Allardice. — It is. The contractors guaranteed that the average efficiency of the wheels when discharging 73, 122, 138 and 155 sec.-ft. under a net head of 90 ft. at a speed of 400 rev. per min. would be 82 per cent., while the average efficiency as computed from the measurements of the amounts of water discharged as determined by the current meters and the pitometer was 80.5 per cent.

Professor Sanborn. — Mention has been made of the continuous running of the plant. Do I understand that the plant runs twenty-four hours daily without any interruptions?

Mr. Allardice. — The operating contract with the Connecticut River Transmission Company requires us to run the plant sixteen hours a day when requested provided we need the the water in the Metropolitan District. There is provision made whereby we may furnish twenty-four-hour service under the same requirements for water. As a matter of fact, the most of our running is confined to the mill hours, eleven hours a day, and we arrange to send the week's water supply in the $5\frac{1}{2}$–11-hour days, thereby conserving our energy to its utmost.

Mr. William S. Johnson. — I would like to ask if any studies were made toward using this power in the pumping stations near the cities. The Metropolitan system might be its own best customer.

Mr. Stearns. — In answer to Mr. Johnson's question, I

do not know that the use of the power in the Metropolitan pumping stations near Boston has ever been specially considered. At the time when the matter was first taken up, the difficulty of transmitting the electricity such a distance through a populated district precluded the idea of such use. The certainty of continuous operation of such large pumping stations is the important feature, and it would be necessary to maintain an adequate steam plant and a sufficient force to operate it, even if the electricity were transmitted, because the supply might be cut off by accident and would not be continuous in any event, as the plant at the dam must be shut down on occasions to conserve the water. Under such circumstances there would probably not be as large a profit from using the electricity as from selling it, but it may be a matter for future consideration.

The electricity has been carried to the sewerage pumping station in Clinton, where the cost of pumping by electricity is very much less than it formerly was with steam pumps. The continuity of service in this case is provided for under the contract for the sale of electricity, the Connecticut River Transmission Company furnishing the power for the sewerage plant when the power plant at the dam is not in operation.

Vol. II MARCH, 1915 No. 3

BOSTON SOCIETY OF CIVIL ENGINEERS
FOUNDED 1848

PAPERS AND DISCUSSIONS

DISCUSSION OF THE COMMISSION-MANAGER FORM OF GOVERNMENT.

By John Balch Blood.

Mr. John Balch Blood (*by letter*). — In his description of the commission-manager form of local government as exemplified of Dayton, Mr. Waite has given a very clear view of the essentials. I feel that this form of government should prove a much greater success than any of our forms of local government, barring the town government with its general town meeting, as it is the only form that conforms to the accepted and reiterated principles of good government. I refer to the separation of the powers of government. It was a prime requirement in the principles of our forefathers in their drafting of constitutions that the legislative, executive and judicial functions of government should be separate. Massachusetts, in her constitution adopted June 15, 1780, stated this with extreme care and almost with redundancy in Article XXX as follows:

"Article XXX. In the government of this commonwealth, the legislative department shall never exercise the executive and judicial powers, or either of them: the executive shall never exercise the legislative and judicial powers, or either of them: the judicial shall never exercise the legislative and executive powers, or either of them: to the end it may be a government of laws and not of men."

The town government conforms to this and is generally regarded as a success. The legislative department is the electo-

rate itself, the town meeting. The executive is the Board of Selectmen. These functions are distinct and separate. Compare this with the common municipal governments having a mayor and council. The council is supposed to be the legislative branch, but you will find that it usually divides itself up into committees and does the executive work. Most of the work for a city government is executive. Now note what the result is in this city government of ours. The council legislates as a body and then executes by various committees. Here is the most beautiful scheme whereby a chairman or member of a committee can put through an order in council that will favor the work in his committee or give him opportunity through his committee to help his own interests. Further, the several chairmen of committees will help each other, on the give-and-take principle, with the general result of log-rolling.

The Dayton plan does have this separation absolutely. The electorate by vote chooses a commission which is the legislative body. This commission elects a manager and the manager appoints the various directors of the executive departments. The executive and legislative departments are absolutely separate and only connected by the provision of original election of manager (elected to serve during good behavior, like Massachusetts judges), and also the provision of recall by the commission and by the electorate. This is the point of paramount success of this form of government, while I see ultimate failure for the ordinary commission form, where the commission is both executive and legislative at once.

The ordinary commission form is likely to stay clean for a while on account of interest, and good unimpeachable men will be chosen. But if the old city government with mayor, veto and cumbersome double chamber was a good instrument for log-rolling, how much more so will be the commission form where the legislative body consists of the five or six executive heads of departments. It will take a pretty strong man to oppose legislation demanded by another executive head. He knows he may sometime want legislative support for his own department.

Personally I believe that the legislative body should be

larger than provided in the Dayton charter; and by inverted approval, and executive temporary orders, have the necessary meetings as few as possible.

Mr. Waite says that "the success of any form of government must ultimately depend on the people." I feel that the direct conclusion from such principle is that the people should be as close to the legislative department as it is possible by form of government to make it. In order to insure that the representative citizens take their places in the legislative body, such place should not require a burdensome obligation of time and attention.

That legislative department is best which carries forth most accurately the will of the community as a whole. Law-abidingness is a necessary attribute of a civilized community. To have this in its largest and best sense we must have the legislative body commensurate with the community as a whole.

I think we can all wish well for Mr. Waite in his work to show the possibilities of this new form of government and at the same time expect much toward the better ordering of our local governments.

MEMOIRS OF DECEASED MEMBERS.

GEORGE BLINN FRANCIS.*

Died June 9, 1913.

George Blinn Francis was born at West Hartford, Conn., January 31, 1857. He was a lineal descendant of some of the very earliest settlers in the Connecticut Valley, the son of Blinn and Lucy (Hart) Francis.

After attending the public schools of his native town, and the Hartford High School, from which he was graduated at the age of seventeen years, he went to Providence, where he took a position as a student in the Engineering Corps during the construction of the Pettaconsett Pumping Station.

In March, 1877, he was transferred to the City Engineer's Department, which had just been consolidated with the Water

* Memoir prepared by John W. Ellis and Edwin J. Beugler.

Works, where he served for the next four and a half years as assistant engineer, being assigned to the corps in charge of the "Brook Street District" improvements, and, on the completion of that work, to the Water Department.

In 1881, he joined the Engineering Department of the New York, West Shore & Buffalo Railroad, and was assigned to the Ulster Division, in charge of a hydrographic corps between Fort Montgomery — at the southern entrance to the Highlands — and Poughkeepsie; later, he was made assistant engineer in charge of four miles of construction on this division.

Early in 1883, Mr. Francis went to the Pacific Coast with a party selected to make surveys for a relocation of the Oregon Railway and Navigation Company's line between Portland and the Dalles, through the Cascade Mountains. In the spring of that year, he was transferred to Portland as assistant engineer in charge of the construction of a large freight terminal, for the Northern Pacific Terminal Company, on the Willamette River, opposite Portland, including the construction of the car-ferry inclines, in connection with the transfer of passengers, for cars across the river, which were to be built in thirty days in order to be in readiness for the transfer of the famous "Gold Spike" party over the Northern Pacific Railway, in September, 1883.

On the completion of this work he returned East, and for the next two years was employed on general railroad work, — design, construction and maintenance, — including the preparation of plans for harbor works under the direction of the late James B. Eads, M. Am. Soc. C. E., in connection with his scheme for a ship railroad at Tehuantepec, and as assistant engineer, on the Hudson River Division (Weehawken to Albany) of the New York, West Shore & Buffalo Railroad, on maintenance of way.

In the fall of 1884, Mr. Francis resigned the latter position to accept that of engineer of the Portland Construction Company, and as such had charge of the design of warehouses, docks, floating pile-driver, coal pockets, bridges, floating dry-dock, etc. Subsequently he became resident engineer on the construction of the Yakima Division of the Northern Pacific Railroad, returning East on the completion of this work. For the

next three years he served in various positions on general railroad work, both design and construction, as follows: In the Engineer Corps on the Blue Mountain and Kittatinny Mountain Tunnels, on the South Pennsylvania Railroad, at Roxbury, Pa.; with the New Jersey Junction Railway, on field location from Weehawken to Bayonne, afterward having charge of the location and construction through Jersey City; and as division engineer on general railroad work on the Western Division of the New York Central & Hudson River Railroad, with headquarters at Rochester, N. Y.

On May 1, 1887, he returned to Providence, R. I., as principal assistant engineer of the New York, Providence & Boston Railroad, remaining in that position until March, 1892, when he was appointed resident engineer of the New York, Providence & Boston, and Old Colony Railroad Terminal Company (subsequently controlled through lease by the New York, New Haven & Hartford Railroad Company), designing and constructing the Providence Terminal.

On July 1, 1896, he became resident and acting chief engineer of the Boston Terminal Company, designing and constructing the South Terminal Station, in Boston, one of the largest passenger terminals in the world. With such care, foresight and skill were the details of this intricate problem worked out that no important change has ever been made in the layout. The study and experience derived from the successful solution of these two important engineering works led Mr. Francis to specialize in this branch of the profession, in which field he was recognized subsequently as a leading authority.

In the spring of 1899, he designed and supervised the construction of the foundations of the Kingsbridge Power Station of the Third Avenue Railroad, in New York City.

On the completion of the Boston Terminal, he became chief engineer of the Providence Street Railway System, and from February, 1900, to June, 1902, served during a very active period of construction and reconstruction of the Company's urban and interurban lines, building a new generating station, repair shops, car barns, etc.

Mr. Francis resigned to accept a position as head of the

Civil Engineering Department of Westinghouse, Church, Kerr & Company, which company had been retained as engineers in connection with the new Pennsylvania Terminal in Manhattan, and, during the next eight years, the important civil engineering features of this work were under his supervision.

Some other terminal problems which received his attention are: The proposed Union Station at Toronto, Ont.; the proposed passenger and freight terminal at Chicago, for the Chicago and Western Indiana Railroad; the Winnipeg Terminal, Grand Trunk Pacific Railway; Vancouver, B. C., Terminal, Canadian Pacific Railway; the proposed freight terminal, Canadian Pacific Railway, at Toronto; the proposed passenger terminal for the City of Buffalo; the rearrangement of the track layout, St. Louis Terminal; and many smaller terminals, both for passengers and freight, in the United States and Canada. As a member of the Railroad Committee of the Merchants Association of New York City, he rendered valuable assistance in the preparation of its report on "The West Side Improvements," relating to railroad and terminal facilities. He thrice visited Europe for observation and study of the large terminals in England and on the Continent.

Some of the many engineering problems which engaged his attention during his connection with Westinghouse, Church, Kerr & Company were as follows:

Supervision of the construction of two high-speed interurban electric roads, one in the Lackawanna Valley, between Scranton and Wilkesbarre, Pa., and the other in the Ohio Valley between Beaver, Pa., and Steubenville, Ohio; general supervision of the reconnaissance, location and plans for a proposed high-speed electric road between Paterson, N. J., and Times Square, New York City; a proposed electric road between Rochester and Syracuse, N. Y., and a proposed line between Baltimore, Frederick and Hagerstown, Md.; consulting engineer on hydro-electric development for the Atlanta Water and Electric Power Company; consulting engineer, Shut-off Dam, Charles River Basin; consulting engineer, deep foundations, Providence Journal Building; consulting engineer, East Side Easy Grade Street, Providence, R. I.; associate consulting

engineer with Gustav Lindenthal, M. Am. Soc. C. E., on reconstruction of Locust Point Pier for the Baltimore & Ohio Railroad, at Baltimore, Md.; consulting engineer, heavy reinforced concrete bridge, designed for Bush and Gunpowder River Bridges, Pennsylvania Railroad; and investigations and reports on various water-power and irrigation projects in the South and West.

Mr. Francis was a member of the American Society of Civil Engineers, The Institution of Civil Engineers of Great Britain, the Boston Society of Civil Engineers, The Canadian Society of Civil Engineers, the New York Railroad Club and the Boston Engineers' Club.

Mr. Francis joined the Boston Society of Civil Engineers, June 16, 1897. He served as director from March 19, 1902, to March 16, 1904. He was the first non-resident member to be honored with the presidency of this Society, which office he filled from March 17, 1909, to March 16, 1910.

The following papers were read by him before the Society:

March, 1898. — "Providence Railroad Terminals."
February, 1900. — "Construction of the South Terminal Station in Boston."
May, 1902. — "Light Mountain Railways."
January, 1904. — "Timber Crib Foundations" and "Description of the Construction of a Double-track Third-Rail Electric Road between Scranton and Wilkesbarre."
November, 1905. — "Construction of Water Power on the Chattahoochee River at Atlanta, Ga."
April, 1907. — "Pennsylvania Railroad Terminal Station in New York, and the Engineering Problems Connected Therewith."
March, 1909. — "Railroad Terminal Improvements in Providence."

He was awarded a gold medal at the Paris Universal Exposition in 1900, in connection with the exhibit of the Boston Terminal Company; and in 1906, he received the honorary degree of Master of Arts from Brown University.

Mr. Francis was a frequent contributor to the American Society of Civil Engineers, and in 1906 he was awarded the Thomas Fitch Howland Prize by the American Society of Civil

Engineers for a paper on the Scranton Tunnel of the Lackawanna and Wyoming Valley Railroad.

He was also a member of the Masonic fraternity, being a past master of What-Cheer Lodge No. 21; Providence Royal Arch Chapter No. 1; Providence Council No. 1, R. & S. M.; Calvary Commandery No. 13, K. T.; and of Rhode Island Consistory, 32d degree, A. A. S. Rite, N. M. J.

Mr. Francis was one of the ablest railroad and general construction engineers. He had much to do with the development of transportation facilities in the New England and Middle States. He was resourceful and bold in dealing with new problems, and when there was no precedent he never hesitated to create one. The soundness of his judgment was apparent in many difficult undertakings. He had the rare faculty of inspiring others to do their very best, and was always noted for fairness and generosity in dealing with subordinates — some of whom, under his direction, were fitted for places of added responsibility and honor.

His genial disposition, democratic spirit and kindly courtesy won for him the unfailing loyalty, unfeigned affection and unwavering devotion of all who ever worked for or with him. His death is keenly felt by a host of friends and business acquaintances, and is a distinct loss to the profession which he loved, in which his life found its expression, and for which he zealously labored.

Mr. Francis always took a very active interest in this Society, and while he was its President gave very much of his valuable time and thought in the promotion and development of many changes in the conduct of the Society's affairs.

At the first joint dinner of the American Society of Mechanical Engineers, the American Institute of Electrical Engineers and the Boston Society of Civil Engineers, he made an address in which he suggested the formation of the Engineers' Club of Boston.

In April, 1882, Mr. Francis was married to Florence Louise Greene, of Providence, R. I., who, with one son, George B. Francis, Jr., survives him.

ALBERT H. HOWLAND.*

ALBERT H. HOWLAND was born on February 25, 1845, at Barnstable on Cape Cod, and came of the old stock of New England, being descended from John Howland, a *Mayflower* pilgrim; and he remained owner of the old Howland homestead to the end of his life.

He had the advantage of a good education. He was prepared for college at Amherst Academy, and graduated at Amherst College in 1865, and later received the degree of Master of Arts there. In 1869 he entered the Massachusetts Institute of Technology as a special student and pursued the mathematical and technical studies of the civil engineering course, obtaining the degree of Bachelor of Science in 1871. He took high rank, especially in mathematics, and had an opportunity, which he did not accept, to become an instructor in mathematics at the Institute.

He engaged in the practice of civil engineering in Boston, making a specialty of bridge and roof construction. He was associated for several years with the late Edward S. Philbrick, C.E. After the bridge disaster of December 29, 1876, at Ashtabula, Ohio, he made a valuable examination and study of the wreck; and his report, addressed to the Ohio legislature's committee appointed to investigate it, was printed with the committee's report by the state printers at Columbus, Ohio, in 1877, pages 35–49. Some conclusions, with Mr. Howland's sketch, may be found in the Transactions of the American Society of Civil Engineers, Vol. VI, pages 85, 86 and 196, 198. His principal work was on bridges in the South and the Middle West; and for a time he was connected with a bridge company. Among the structures upon which he was employed are said to have been the roofs of Memorial Hall at Harvard University and the former building of the Boston Young Men's Christian Association at the corner of Boylston and Berkeley streets.

In the latter part of his life he relinquished professional business in great measure. He shared an office with some other gentlemen and had books and periodical publications there and

* Memoir prepared by Frederick Brooks and Frank L. Fuller.

was obliging in supplying information to inquiring friends, being regarded as an encyclopedic source of accurate knowledge. He was, however, quite reticent about his own affairs, of which the persons closest to him were ignorant. He visited regularly on Sundays some of his nearest relatives, who were cousins, and endeared himself to the children as a playfellow. He occupied the same bachelor quarters at 43 Concord Square, Boston, for twenty-six years, but his landlady knew scarcely anything about him. He died there suddenly on April 5, 1914, and the medical examiner found that the heart was affected. Burial was in the family lot at West Barnstable.

Mr. Howland took a deep interest in the Boston Society of Civil Engineers, and was exemplary in faithful attendance for forty years at its meetings and excursions. He occasionally took part in its proceedings, and was keen and skillful in his preparation of material, an example of which may be found in the *Journal of the Association of Engineering Societies*, Vol. IV, pages 12–14, for November, 1884. His watchfulness over the administration of the Society's affairs was useful, even if it sometimes seemed a thankless service; and he had a sense of humor withal. He was a man of sterling integrity and of agreeable disposition, and his loss is felt and deplored by his fellow-members.

LUCIAN A. TAYLOR.*

LUCIAN ARNOLD TAYLOR, the youngest son of Jared and Catharine (Truesdell) Taylor, was born at Harrisville, R. I., on June 20, 1846. The son of a farmer, he passed his early years on his father's farm in Woodstock, Conn., working during the summer and attending school in winter.

In response to President Lincoln's call for men to defend the Union, Mr. Taylor offered his services, but because of his age he was not accepted. But on July 15, 1862, he enlisted in Company B, 18th Connecticut Volunteers, and continued in the

* Memoir prepared by William E. McClintock and Frank E. Hall.

service until the close of the war in 1865. During all this time he was in active service excepting about four months when he was a prisoner of war at Richmond and at home recovering from his severe prison experience.

The two years after leaving the army were passed in Woodstock, working on the farm and at the same time attending the Woodstock Academy.

In 1867 Mr. Taylor moved to Worcester, Mass., where he attended Howe's Business College.

In 1868 he received an appointment as assistant by Phineas Ball, city engineer of Worcester, and started off on what was to be his life's work. He served the city faithfully for fourteen years, during which time he was the engineer in charge of rebuilding the Leicester dam in 1876, of building the Island sewer in 1878–1879, and of building the first Holden dam in 1883. These were works of magnitude and offered obstacles that called not only for engineering skill but for great ability along practical lines. Mr. Taylor met all the demands upon him and developed the traits which later were to make him so successful.

In 1884 he was elected water commissioner, which position he held for one year.

In 1885 he entered the contracting firm of William C. McClellan & Co., of Boston. In 1886, upon the death of his partner, Mr. Taylor bought Mrs. McClellan's interest in the firm, and from that time to his death carried on the business of consulting engineer and contractor.

That Mr. Taylor was successful in his dual capacity as engineer and contractor is evidenced by the large number of important works which he both planned and built. Still further proof of his ability and integrity comes from the fact that he was called in the same capacity to extend works which he built. His boyhood experience on the farm enabled him to accomplish much physically, and his moral qualities made him see clearly the line of demarcation between the duties of engineer and contractor, and he never permitted personal gain to warp his judgment or influence his action. Among the most important works of Mr. Taylor's may be enumerated the water works at Bar Harbor, Kingsfield and Cumberland Mills, Me.; of New-

port, N. H.; of St. Albans and St. Johnsbury, Vt.; of Lynn, Orange, Quincy, Webster, Millbury, Concord, Provincetown and Rutland, Mass.; and of New Haven, New London and Groton, Conn. He devoted most of his time during the past several years to consulting work.

When, in 1913, because of illness, he retired from active work, he was consulting engineer for the city of Lynn and the town of Falmouth, Mass. He also was president of the Millbury, Mass., Water Company, which position he had held for several years.

He retained his residence in Worcester during the twenty-nine years he maintained his Boston office.

His genial personality brought a host of friends. His sterling integrity commanded the respect of everyone who knew him.

Mr. Taylor's death occurred at his home in Worcester on November 19, 1914, after an illness of more than a year, and was caused by a complication of diseases.

He married, on August 29, 1868, Jeannette Arnold, of Putnam, Conn., who with one son and one daughter survives him.

Mr. Taylor was elected a member of the Boston Society of Civil Engineers, September 21, 1887. He also was a member of the American Society of Civil Engineers, the Engineers' Club of Boston, the American Water Works Association, the New England Water Works Association, the Worcester County Society of Engineers, the Worcester County Mechanics Association and George H. Ward Post 10, G. A. R.

Vol. II APRIL, 1915 No. 4

BOSTON SOCIETY OF CIVIL ENGINEERS
FOUNDED 1848

PROCEEDINGS

NOTICE OF REGULAR MEETING.

A REGULAR meeting of the Boston Society of Civil Engineers will be held on

WEDNESDAY, APRIL 21, 1915,

at 7.45 o'clock P.M., in CHIPMAN HALL, TREMONT TEMPLE, BOSTON.

Mr. J. Albert Holmes will read a paper entitled "Construction of the Earth Dam at Somerset, Vermont." Mr. Holmes, who was the resident engineer during the construction of this dam, will illustrate his paper with a number of lantern slides showing the work during its construction.

S. E. TINKHAM, *Secretary.*

PAPERS IN THIS NUMBER.

"The Elimination of Grade Crossings," L. Bayles Reilly.

Address at the Annual Meeting, March 17, 1915, Harrison P. Eddy.

Address at the Annual Meeting of the Sanitary Section, March 3, 1915, Bertram Brewer.

CURRENT DISCUSSIONS.

Paper.	Author.	Published.	Discussion Closes.
"Insurance for Engineers."	N. H. Daniels.	March.	May 15.

Contributors are hereby notified that proof will not be submitted to them for examination unless requested before the 10th of the month preceding the month of publication.

MINUTES OF MEETINGS.

BOSTON, February 24, 1915. — A special meeting of the Society was held this evening in the Society Rooms, and was called to order by the President, Harrison P. Eddy, at 8 o'clock. There were 56 members and visitors present.

The meeting was held to discuss some of the problems of the inspector. The particular topic taken up was, "Rust on Reinforcing Rods and Its Effect on the Strength of Concrete."

The discussion was opened by Mr. J. R. Worcester, who was followed by Messrs. C. R. Gow, P. B. Walker, A. O. Doane, R. A. Hale, H. F. Bryant, J. L. Howard and others of the Society, and by Prof. W. C. Voss of the Wentworth Institute of Boston.

Adjourned.

S. E. TINKHAM, *Secretary.*

BOSTON, March 10, 1915. — A special meeting of the Society was held in the Assembly Hall of the Engineers Club this evening, and was called to order by the President, Harrison P. Eddy, at 8 o'clock. There were 65 members and visitors present.

The President introduced the speaker of the evening, the Hon. James Logan, ex-mayor of Worcester, Mass., who delivered an exceedingly interesting address entitled "The Public Service Corporation and the Municipality."

Discussion followed, in which Mr. F. J. Macleod, chairman of the Public Service Commision, and Mr. Alonzo R. Weed, chairman of the Board of Gas and Electric Light Commissioners, took part.

S. E. TINKHAM, *Secretary.*

BOSTON, March 17, 1915. — The sixty-seventh annual meeting of the Boston Society of Civil Engineers was held at the new club-house of the Boston City Club, Somerset Street, Boston, at 12 o'clock M., President Harrison P. Eddy in the chair.

The reading of the record of the last regular meeting was,

by vote, dispensed with and it was approved as printed in the March JOURNAL. The records of the special meetings held on February 24 and March 10 were read by the Secretary, and by vote they were approved.

The Secretary reported for the Board of Government that it had, on March 5, 1915, elected to membership in the grades named, the following candidates:

Members — Robert Edward Barrett, John James Eisnor, Leroy Ernest Gardner, Harry Gilbert Hunter, Abraham Lincoln Lampie, Richard James McNulty, Edward Smulski and David Y. Swaty.

Juniors — Herbert Nelson Ackerson, Walter Harrington and Joseph Ernest Roy.

It had also elected, by unanimous vote, as honorary members, Clemens Herschel and Hiram F. Mills.

The Secretary read the annual report of the Board of Government, and by vote it was accepted and ordered to be placed on file.

The Treasurer presented and read his annual report. By vote, it was accepted and ordered to be placed on file. He also read the report of the auditing committee, and by vote it was accepted and ordered to be placed on file.

The Secretary read his annual report, and by vote it was accepted and ordered to be placed on file.

Mr. Wason, chairman of the Excursion Committee, made a verbal report which was accepted.

The Librarian read the annual report of the Committee on the Library, and by vote the report was accepted and ordered to be placed on file.

The Secretary read the annual report of the Committee on Social Activities, and by vote it was accepted and ordered to be placed on file.

On motion of Mr. C. W. Sherman, it was voted to refer to the Board of Government, with full powers, the question of appointing the special committees of the Society.

On motion of Past-President Fay, the following resolution was unanimously adopted:

Resolved, that the thanks of the Boston Society of Civil

Engineers are hereby tendered to Roland B. Pendergast for his efficient services in preparing and securing the publication of suitable press notices relating to the activities of the Society during the past year.

On motion of Mr. C. W. Sherman, the following vote was unanimously adopted:

Voted, that the thanks of the Society be extended to the Hon. James Logan for the very able and interesting address which he delivered at the special meeting of March 10, 1915.

It was also voted unanimously to send some flowers to Mr. E. M. Blake, chairman of the Committee on Social Activities, who is confined to his house by serious sickness, and to express to him the best wishes of the Society and its earnest hope for his speedy restoration to health.

The President read a letter from Prof. George F. Swain, chairman of the Boston Transit Commission, extending an invitation to the members of the Society to visit this afternoon the new Washington Station of the Dorchester Tunnel Subway.

The retiring President, Mr. Harrison P. Eddy, then delivered an address, entitled "The Duties and Sphere of Action of a Local Engineering Society with Special Reference to the Boston Society of Civil Engineers."

The members then adjourned to the auditorium of the club, to partake of the thirty-third annual dinner. At the close of the dinner, business was resumed, and Past-President Henry F. Bryant, at the request of the President, presented, in the name of the Society, the Desmond FitzGerald medal for the year 1914 to Joseph Ruggles Worcester, for his paper entitled "Boston Foundations." Mr. Worcester expressed his appreciation of the honor accorded him in the presentation of the medal, and thanked the Society for the same.

The tellers of election, Messrs. Hiram A. Miller and Henry B. Wood, then submitted their report giving the result of the letter ballot. In accordance with this report the President announced that the following officers had been elected:

President — Charles R. Gow.
Vice-President (for two years) — Ralph E. Curtis.

Secretary — S. Everett Tinkham.

Treasurer — Frank O. Whitney.

Directors (for two years) — Edmund M. Blake and George C. Whipple.

The President then called upon Mr. Robert Spurr Weston and Mr. Irving E. Moultrop, each of whom had received hearty support for the office of president, to tell the members what they had proposed doing if they had been elected. They responded in a facetious vein which was thoroughly enjoyed by the members. The President-elect, Mr. Charles R. Gow, was then presented and responded in a similar happy manner, but concluded by expressing his sincere thanks for the honor they had bestowed on him in this election and promised to do all in his power to forward the best interests of the Society.

Mr. Frederick H. Newell, consulting engineer, United States Reclamation Service, then delivered an illustrated lecture on " Engineering and Economic Results Obtained by the United States Reclamation Service," to which address his audience listened with deep interest.

In the evening the " Smoker " was held in the auditorium, the attendence being 260. There was music by an orchestra, the old songs and some new ones by members, and an entertainment by Mr. Thrasher in Canadian patois and Mr. Starbuck on the xylophone. Light refreshments were served during the evening.

S. E. Tinkham, *Secretary.*

Boston, March 31, 1915. — A special meeting of the Boston Society of Civil Engineers was held this evening at Chipman Hall, Tremont Temple, and was called to order by the President, Charles R. Gow. There were 104 members and visitors present.

The President introduced Mr. Edward F. McSweeney, Chairman of the Directors of the Port of Boston, who gave an address on " The Future of the Port of Boston." The address was illustrated by a number of lantern slides and maps. A short discussion followed the address, during which Mr. McSweeney

very kindly answered a number of questions asked by those present.

On motion of Past-President Eddy, a rising vote of thanks was tendered Mr. McSweeney for his kindness in presenting, in so interesting a manner, the topic of the evening.

Adjourned.

S. E. Tinkham, *Secretary.*

ANNUAL REPORTS.

Annual Report of the Board of Government for the Year 1914–15.

Boston, Mass., March 17, 1915.

To the Members of the Boston Society of Civil Engineers:

Pursuant to the requirements of the Constitution, the Board of Government presents its report for the year ending March 17, 1915.

The total membership of the Society a year ago was 837, of whom 762 were members, 37 juniors, 2 honorary members, 22 associates, and 14 were members of the Sanitary Section only.

The total loss in membership during the year has been 33, of whom 19 resigned, 10 forfeited membership on account of non-payment of dues and 4 have died.

There has been added to the Society during the year a total of 124 members of all grades: 120 have been elected and have completed their membership, 4 have been reinstated, 4 juniors and 1 associate have been transferred to the grade of member, and 1 member has been made an honorary member; 23 have been elected to membership but have not as yet completed their membership, and one honorary member has not yet accepted his election. Fifty-two applications are now before the Board for action.

The present membership of the Society consists of 3 honorary members, 832 members, 58 juniors, 24 associates and 11 members of the Sanitary Section only, making a total membership of 928; to this might be added those who have not completed their membership and whose applications are still before the Board, making a grand total of 1 004.

The Board of Government by unanimous vote has elected as honorary members, Clemens Herschel of New York City, who joined the Society June 8, 1874, and continued his membership to date; and Hiram F. Mills, of Lowell, Mass. Mr. Herschel served as treasurer of the Society from September 4, 1874, to March 17, 1880, and as president from March 17, 1890, to March 18, 1891.

The record of deaths during the year is —

Albert H. Howland, died April 5, 1914.

Clifford N. Cochrane, died August 8, 1914.

Levi G. Hawkes, died November 8, 1914.

Lucian A. Taylor, died November 19, 1914.

By virtue of authority granted by By-Law 8, the Board of Government, for reasons which it deems sufficient, have remitted the dues of twenty-three members of the Society.

Ten regular and four special meetings have been held during the year. The average attendance at the ten regular meetings was 152, the largest being 396 and the smallest 63; and at the four special meetings the average attendance was 52, the largest being 65 and the smallest 36.

The following papers and talks have been given at the meetings:

March 18, 1914. — Nelson P. Lewis, "City Planning from the Standpoint of the Engineer." (Illustrated.)

March 25, 1914 (special meeting).— Leslie H. Allen, "Cost Accounting on Construction Work."

April 15, 1914.— J. S. Miller, Jr., "Asphalt and Asphaltic Street and Road Construction." (Illustrated with motion pictures.)

May 24, 1914.— Edward S. Larned, "The Manufacture of Portland Cement." (Illustrated with motion pictures.)

June 10, 1914.— Lester W. Tucker, "The Phosphate Rock Industry of Florida." (Illustrated.)

September 16, 1914.— C. A. P. Turner, "The Mechanics of Reinforced Concrete under Flexure in Beam and Slab Types."

October 21, 1914. — Col. William D. Sohier, "French, English and American Roads and Road Systems." (Illustrated.)

November 18, 1914. — Henry M. Waite, "The Commission-Manager Form of Government and Its Relation to the Engineering Profession."

December 16, 1914. — E. R. B. Allardice and Burdett C. Thayer, "The Hydro-Electric Power Plant at the Wachusett Dam, Clinton, Mass." (Illustrated.)

January 13, 1915 (special meeting). — Discussion of paper on "Construction Management," prepared by Sanford E. Thompson and William O. Lichtner.

January 27, 1915. — Nathan H. Daniels, "Insurance as an Aid to Engineers." (Illustrated.)

February 17, 1915. — William S. Johnson, "Ground Water Supplies." (Illustrated.)

February 24, 1915 (special meeting). — Topic of discussion, "Rust on Reinforcing Rods and Its Effect on the Strength of Concrete."

March 10, 1915 (special meeting). — Hon. James Logan, "The Public Service Corporation and the Municipality."

The Sanitary Section has held six meetings, with an average attendance of 53. The following papers have been presented at the meetings of the Section:

March 4, 1914. — "The Collection and Treatment of Sewage in Their Relation to the City of Philadelphia," George S. Webster.

May 11, 1914. — "The Development and Present Status of Sewage Purification in England," Arthur J. Martin.

November 27, 1914. — "The Industrial Wastes of Chicago, with Particular Reference to the Packing Industry," Langdon Pearse.

December 9, 1914. — "The Economic Depth of Trickling Filters," Harrison P. Eddy. "A Study of Depth of Filter Material in Connection with Trickling Filter Efficiency," H. W. Clark.

January 6, 1915. — "Diatoms," F. F. Forbes and Dr. J. W. M. Bunker.

February 3, 1915. — "Garbage Disposal at Worcester, Mass.," Dr. Frederic Bonnet, Jr. "Garbage Reduction Plants at Cleveland, Schenectady and New Bedford," W. J. Springborn.

The Sanitary Section made an excursion to Fitchburg, Mass., on June 3, 1914, which included an inspection of the sewage treatment works. The members were entertained by the city at lunch and with a trolley trip to Whalom Park and Wachusett Lake. The attendance was 65.

Coöperation with local members of the American Society of Mechanical Engineers and the Boston Section of the American Institute of Electrical Engineers has been continued as during the past few years, a joint meeting having been held under the auspices of each society. The Joint Engineering Dinner was held on February 15, 1915, the Boston Society of Civil Engineers taking the initiative. The attendance at this meeting was 275. James W. Rollins, past president of this Society, acted as toastmaster. The meeting was addressed by his Excellency Governor Walsh and others, and proved to be a very enthusiastic gathering and an enjoyable and profitable meeting.

The Board of Government has adopted the recommendation of the committee appointed to award the Desmond FitzGerald medal, and announces that it will be given this year to Joseph R. Worcester, past president, for the paper entitled, "Boston Foundations," presented January 28, 1914.

The work of rearranging and cataloguing the library has been continued, and during the last three months, on account of the pressure of clerical work, a stenographer has been employed, thus enabling the assistant librarian to devote more time to the library work.

The Board has added to the furnishings of the rooms, at a cost of $237.94, which sum has been paid from the special appropriation of $2 000 made from the Permanent Fund in November, 1912. The balance of this fund unexpended is $613.52; such part of which as is not expended prior to November 20, 1915, will revert automatically to the Permanent Fund.

On May 20, 1914, the Society made from the Permanent Fund a special appropriation not to exceed the amount of the entrance fees for the fiscal years 1913 and 1914, for use in meeting current expenses this year. The amount which could have been expended under this authorization is $1 400. The Board, however, has expended from this appropriation only the sum of $101.50, and that for the purchase of books for the Library.

Interest on the Permanent Fund has amounted to $1 634.34 during the year. This fund now amounts to $34 582.13, not including the balance in the appropriation for furnishing, and over $35 000 including this balance.

The Editor has submitted a report covering the first volume of the Journal, published during the calendar year 1914, which is submitted for publication with the reports of the other officers of the Society. This report shows that the volume contained 914 pages in all, with 114 cuts and 26 inserted plates, and that the gross cost was $4 285.74. The net cost, after deducting sums received for advertising, sales of the Journal, etc., was $2 660.93, an average of $266.09 for each number. This figure would have been con-

siderably less except for the abnormal cost of the plates accompanying the valuable paper on "Boston Foundations." The average net cost for the other nine issues was about $180.

The average net cost to the Society of the *Journal of the Association of Engineering Societies* in previous years was about $2 000 per year, in addition to which the *Bulletin* showed an average gross cost of about $780, and a net profit of about $150, making the total net cost of the Society's publications under the old arrangement about $1 850 per year, or substantially the same as the net cost of our present JOURNAL under normal circumstances.

It was originally hoped that it might be possible to reprint at the end of the year the papers and discussions appearing in the JOURNAL, thus arranging the discussions to follow the papers to which they pertain, and bringing together in a single volume all of the transactions of the Society, eliminating the notices, proceedings of meetings, and other material primarily of temporary interest; and with this object in view the type was kept standing until the end of the year. But estimates prepared when the amount of material in the volume was known indicated that the cost would be prohibitive, and the Board of Government therefore abandoned the idea.

With the completion of the first volume of the JOURNAL, the experimental period may be said to have passed. It has now been demonstrated that the Society can publish its own journal without its proving a financial burden. This volume appears to come fully up to the expectations of our members, and has been well received by the profession.

By vote of the Board, Mr. Edward C. Sherman has been continued as Editor of the JOURNAL.

The increase in membership will result in an increase of receipts from dues. The Treasurer estimates the receipts applicable to current expenses for next year at about $8 800, an increase of about $630 over the receipts of the past year.

A committee of the Board has given careful consideration to the needs of our younger members, and has recommended to the Board that several meetings be arranged for their particular benefit, and suggested that it may be wise to provide a prize, probably in the form of a medal, to encourage the preparation and presentation of papers by the younger members. The Board approves the recommendations of this committee, and suggests that they be put into effect.

The Committee on Membership, under the leadership of Frederic H. Fay, past president, has conducted a vigorous campaign for new members which has met with marked success. A total of 197 applications for membership has been procured.

A Committee on Social Activities was appointed early in the year, for the purpose of encouraging sociability at meetings. It was decided to try the experiment of having dinners before the regular meetings, and as this movement appeared to meet with general approval, several such dinners

have been arranged, the details of which are given in the report of the committee, of which Edmund M. Blake is chairman. The dinners have been enlivened by music, story-telling and other forms of amusement, which have added much to their popularity.

An excellent series of papers has been provided by the Committee on Papers and Program, L. E. Moore, chairman, and the committee has not only obtained speakers for fully as many meetings as are usually held, but found itself at the end of the year with a surplus of material which is available for beginning the work of the next year.

For the Board of Government,

Harrison P. Eddy, *President.*

Report of the Treasurer.

Boston, March 17, 1915.

To the Boston Society of Civil Engineers:

Your Treasurer presents the following report for the year 1914–15.

Detailed data are contained in the appended tabular statements; Table 1, profit and loss statements for four years; Table 2, comparative balance sheets; Table 3, investment of the Permanent Fund; and Table 4, statement of cash balance.

The revenue applicable to current expenses has been \$8 171.57, nearly three hundred dollars greater than for the preceding year. The amount received for dues was, however, almost identical with that for the preceding year. The current expenses were \$8 255.97, — an excess of \$84.40 over revenue, — while the deficit of the preceding year was \$774.44. The surplus in the current funds has been reduced to \$451.31.

Owing to the large increase in membership, there should be a considerable increase in revenue next year. There will probably be available an income of about \$8 800, which should be adequate to cover the expenses of the year, even if the Society's activities should be considerably increased, with resulting increased expense.

There has been added to the Permanent Fund during the year \$2 819.34, and there has been expended from the fund, under the authority of a vote of the Society, \$101.50, leaving a net gain in the Permanent Fund of \$2 717.84. The present value of this fund, excluding the appropriation for altering and improving the rooms, and without allowance for accrued interest, is \$34 582.13. This, however, is based upon the "book value" of our securities, and would be about seven hundred dollars less if current market prices be used. The statement of book value is based, in general, upon actual costs to us, and is, it is believed, a fairer statement of real values than present market prices would indicate. Including the unexpended balance of the appropriation for furnishing the rooms, — which will revert to the fund if not used by November next, — the present value of the Permanent Fund is in excess of \$35 000. Of this appropriation \$237.94 has been expended during the year, leaving a balance of \$613.52.

Making approximate allowance for the amortization of bonds bought above or below par, the interest return upon the Permanent Fund is at the rate of 5.1 per cent.

In terminating five years of service as your Treasurer, I have thought it interesting to compare the financial condition of the Society during the last year of service of each of the last four treasurers, by tabulating the figures for current revenue, current expenses, value of Permanent Fund and total assets. The results are as follows:

Year.	Treasurer.	Period of Service. Years.	Current Revenue.	Current Expenses.	Value of Permanent Fund.	Total Assets.
1892	Henry Manley	12	$1 608.68	$1 420.58	$3 928.78	$4 412.52*
1906	Edw. W. Howe	14	5 270.77	5 706.90	18 813.33	18 833.53*
1910	Wm. S. Johnson	4	5 192.00	5 526.18	25 842.64	34 330.15
1915	Chas. W. Sherman	5	8 171.57	8 255.97	35 195.65	45 218.45

* Not including library and furniture.

Respectfully submitted,

CHARLES W. SHERMAN, *Treasurer.*

TABLE 1. — PROFIT AND LOSS STATEMENTS.

	1911–12.	1912–13.	1913–14.	1914–15.
Revenue:				
Members' Dues	$6 448.50	$6 443.00	$6 671.59	$6 675.58
Advertisements (net)	984.50	938.50	973.00	1 286.38
Sales of JOURNAL	8.25	9.40	33.55	130.28
Library Fines	5.56	7.28	8.01	6.42
Interest	22.81	95.30	159.25	72.91
Excursion Committee	....	....	52.94	....
Total Current Income	$7 469.62	$7 493.48	$7 898.34	$8 171.57
Entrance Fees	$410.00	$525.00	$315.00	$1 085.00
Contributions	100.00	100.00	100.00	100.00
Interest	1 301.72	1 277.70	1 515.45	1 634.34
Total Income Permanent Fund	$1 811.72	$1 902.70	$1 930.45	$2 819.34
Appropriation from Permanent Fund	....	$2 000.00	....	$101.50
Balance from Previous Appropriation	....	....	$1 051.40	851.46
Total Available from Appropriations	....	$2 000.00	$1 051.40	$952.96
Projecting Lantern, called	....	....	....	$400.00
Deficit for the year (current funds)	....	....	$774.44	84.40
	$9 281.34	$11 396.18	$11 654.63	$12 428.27

Expense:	1911–12.	1912–13.	1913–14.	1914–15.
Association of Engineering Societies	$2 010.00	$2 026.25	$1 564.38	....
Bulletin	763.83	783.49	687.75	....
JOURNAL B. S. C. E. (incl. Editor's salary)	....	....	1 473.53	$3 206.36
Printing, Postage, Stationery	593.16	644.46	838.54	1 049.29
Rent (net)	920.00	1 320.75	1 632.00	1 620.00
Light	49.68	70.31	62.38	77.44
Salaries (except Editor)	992.00	1 248.50	1 358.00	1 554.00
Reporting	68.00	20.50	41.00	46.00
Stereopticon	130.00	134.50	107.50	79.00
Books	40.53	52.11	33.10	69.73
Binding	169.30	81.15	197.25	141.45
Periodicals	47.00	34.25	58.15	56.10
Incidentals and Repairs	84.94	87.77	62.40	104.41
Insurance	26.38	26.38	41.87	41.18
Telephone	65.24	66.27	50.82	43.53
Sanitary Section Incidentals,	14.24	22.55	64.90	49.35
Annual Meeting and Dinner,	220.82	73.09	73.38	72.90
Furniture	34.25	2.50	....	....
Navigation Congress	....	20.00	20.00	20.00
Students' Meeting	....	154.50	206.48	....
Catering	....	....	45.00	....
Excursions	....	....	38.00	7.50
Lantern Slides	....	....	16.35	....
Engineers' Joint Dinner	....	....	....	17.73
Total Current Expense	$6 229.37	$6 869.33	$8 672.78	$8 255.97
Books (special appropriation from Permanent Fund,	....	....	....	$101.50
Furniture	....	$573.15	$149.50	$225.34
Alterations in Rooms	....	375.45	50.44	12.60
Total expended from Appropriations	....	$948.60	$199.94	$339.44
Permanent Fund increase	$1 811.72	$1 902.70	$1 930.45	$2 717.84
Unexpended Balance of Appropriation	....	1 051.40	851.46	613.52
Increase for the year, Current Funds	1 240.25	624.15	....	....
Projecting Lantern, called	....	....	....	400.00
	$9 281.34	$11 396.18	$11 654.63	$12 428.27

NOTES ON TABLE 1.

Dues.	The Secretary has paid over as dues	$6 685.58
	of which $68 is in advance for next year	68.00
	leaving as current dues	$6 617.58
	in addition to which there was paid in advance last year	58.00
	making the total dues for the current year	$6 675.58
Rent.	Paid for rooms, 12 months at $206.25	$2 475.00
	Paid for Chipman Hall, 8 x $15	120.00
	Paid for Lorimer Hall, 1 x 25	25.00
		$2 620.00
	Less rent from subtenants, collected by the Secretary	1 000.00
	Net rent for the year	$1 620.00
Advertising.		
	The Secretary has collected and paid over	$1 407.00
	from which commissions of	120.62
	have been deducted, leaving the net revenue from this source	$1 286.38

TABLE 2. — COMPARATIVE BALANCE SHEETS.

	March 19, 1913.	March 18, 1914.	March 17, 1915.
Assets:			
Cash	$353.26	$119.41	**$1 267.73**
Bonds and Notes	26 615.50	27 605.50	**29 191.75**
Stock	....	1 950.00	**1 950.00**
Coöperative Banks	5 315.80	3 545.72	**3 212.65**
Accounts Receivable (rent)	145.83	145.83	**145.83**
Library	7 500.00	7 500.00	**7 500.00**
Furniture	1 175.65	1 325.15	**1 950.49**
	$41 106.04	$42 191.61	**$45 218.45**
Liabilities:			
Permanent Fund	$29 933.84	$31 864.29	**$34 582.13***
Unexpended Appropriations	1 051.40	851.46	**613.52†**
Current Funds	1 310.15	535.71	**451.31**
Accounts Payable	135.00	115.00	**121.00**
Surplus	8 675.65	8 825.15	**9 450.49**
	$41 106.04	$42 191.61	**$45 218.45**

* Not including accrued interest and dividend, amounting on March 1 to $341.42.
† Will revert to Permanent Fund unless used prior to November 20, 1915.

TABLE 3. — INVESTMENT OF THE PERMANENT FUND, MARCH 17, 1915.

	Par Value.	Actual Cost.	Present Market Value.*	Value as Carried on Books.
Bonds.				
American Tel. & Tel. Co. col. tr. 4%, 1929	$3 000.00	$2 328.75	$2 640.00	$2 737.50
Republican Valley R. R. 6%, 1919	600.00	616.50	606.00	618.00
Union Elec. Lt. & Pr. Co. 5%, 1932	2 000.00	2 050.00	2 000.00	2 050.00
Blackstone Valley Gas & Elec. Co. 5%, 1939	2 000.00	1 995.00	1 980.00	1 995.00
Dayton Gas Co. 5%, 1930	2 000.00	2 000.00	1 940.00	2 000.00
Milford & Uxbridge St. Ry. 5%, 1918	3 000.00	2 942.50	2 970.00	2 942.50
Railway & Lt. Sec. Co. 5%, 1939	3 000.00	3 000.00	2 910.00	3 000.00
Superior Water, Lt. & Pr. Co. 4%, 1931	3 000.00	2 505.00	2 470.00	2 505.00
Wheeling Elec. Co. 5%, 1941	3 000.00	2 895.00	2 820.00	2 895.00
Economy Lt. & Pr. Co. 5%, 1956	1 000.00	990.00	975.00	990.00
Tampa Elec. Co. 5%, 1933	2 000.00	2 000.00	1 960.00	2 000.00
Galveston-Houston Elec. Ry. Co. 5%, 1954	2 000.00	1 940.00	1 920.00	1 940.00
Northern Texas Elec. Co. 5%, 1940	2 000.00	1 932.50	1 860.00	1 932.50
Chicago & Northwestern Ry. 5%, 1987	1 000.00	1 102.50	1 102.50	1 102.50
	$29 600.00	$28 297.75	$28 153.50	$28 708.00
Note.				
Dallas Elec. Co. 5%, 1917	500.00	483.75	485.00	483.75
Stock.				
15 shares Am. Tel. & Tel. Co.	1 500.00	1 950.00	1 800.00	1 950.00
Total Securities	$31 600.00	$30 731.50	$30 438.50	$31 141.75

* As of March 1, 1915.

Co-operative Banks:	
25 shares Merchants Coöperative Bank, including interest to March	$1 388.05
25 shares Volunteer Coöperative Bank, including interest to January	1 051.55
25 shares Watertown Coöperative Bank, including interest to December	773.05
	$3 212.65
Total Value of Invested Funds	$34 354.40
Cash	227.73
Total Value of Permanent Fund	$34 582.13*

* Not including accrued interest and dividend, amounting to $341.42, nor unexpended balance of appropriation, amounting to $613.52.

TABLE 4. — STATEMENT OF CASH BALANCE, MARCH 17, 1915.

Value of Current Funds	$451.31
Add Accounts Payable	121.00
	$572.31
Deduct Accounts Receivable	145.83
Cash on hand, Current Funds	$426.48
Unexpended Balance of Appropriation for Furnishing	613.52
Unappropriated Cash belonging to Permanent Fund	227.73
Total Cash on hand (in Old Colony Trust Company)	$1 267.73

REPORT OF THE AUDITING COMMITTEE.

BOSTON, MASS., March 15, 1915.

We hereby certify that we have this day examined the books and records of the Treasurer of the Boston Society of Civil Engineers for the year 1914–15; that all receipts are properly accounted for and that there are proper vouchers for all expenditures.

We have also examined the securities and investments of the Society's funds, have verified and compared the same with the books and found them all accounted for and properly carried.

We have compared the financial statement of the Treasurer with the books and find it to be correct.

LEONARD C. WASON,
JOHN N. FERGUSON,
Directors.

Annual Report of the Secretary, 1914–1915.

Boston, Mass., March 17, 1915.

S. Everett Tinkham, Secretary, *in account with the* Boston Society of Civil Engineers. *Dr.*

For cash received during the year ending March 17, 1915, as follows:

From entrance fees, new members and transfers:

93 members and associates .... at $10 =	$930.00		
27 juniors .... at 5 =	135.00		
4 juniors transferred to members .... at 5 =	20.00		
Total from entrance fees		$1 085.00	
From annual dues for 1914–15, including dues from new members	$6 595.58		
From back dues	22.00		
From dues for 1915–16	68.00		
Total from dues		6 685.58	
From rents		1 000.00	
From advertisements		1 407.00	
From sale of Journals, reprints and cuts		194.78	
From contribution to building fund		100.00	
Total		$10 472.36	

The above amount has been paid to Treasurer, whose receipts the Secretary holds.

We have examined the above report and found it correct.

John N. Ferguson,
Leonard C. Wason,
Auditing Committee of Directors of the Boston Society of Civil Engineers.

Annual Report of Library Committee, 1914–15.

Boston, Mass., March 17, 1915.

To the Boston Society of Civil Engineers:

The Library Committee submits herewith its annual report for the year ending March 17, 1915.

Since the last report 280 volumes bound in cloth and 460 volumes bound in paper have been added to the library, the total number of accessions being 740.

There are now 7 780 cloth-bound volumes in the library. Those bound in paper still number about 2 000, the additions for the year, as usual, nearly balancing the number bound.

During the year 296 books have been loaned to members, and fines to the amount of $6.42 have been collected.

A considerable amount of binding has been done, and the files of bound periodicals and society publications are in much better shape than a year ago.

Files of the following society publications are now complete: Transactions of the American Institute of Mining Engineers, Transactions of the Canadian Society of Civil Engineers, Journal of the Western Society of Engineers, and Proceedings of the Engineers' Society of Western Pennsylvania. Thirty-nine volumes of the Minutes of Proceedings of the Institution of Civil Engineers (London) have been added during the year, the earlier volumes by purchase, and the file is now complete from and including volume 23 to date. As this set of books is frequently consulted, it is hoped that the remaining volumes may be secured. A nearly complete set of the Transactions of the American Society for Testing Materials, presented to the Society by Mr. L. C. Wason, is now on the shelves, and the committee recommends that the volumes needed to complete the set be purchased.

Fifteen new engineering books have been bought for Section 10 during the year, and three others, Volumes I and II of "American Sewerage Practice," by Messrs. Leonard Metcalf and Harrison P. Eddy, and Part I of "Concrete-Steel Construction," by Messrs. Henry T. Eddy and C. A. P. Turner, have been presented to the library by the authors.

The need of a good encyclopedia has long been felt, and the committee has recently purchased a set of the Encyclopædia Britannica, ninth edition, in twenty-five volumes, and a set of the New International Encyclopædia is being received as the respective volumes come from the press. The latter set, when complete, will number twenty-four volumes. To the indexes available in the reading room the Industrial Arts Index has been added, which publication comes to us highly recommended and seems to be appreciated by those using the library.

Mr. Clemens Herschel, continuing his generous policy of past years, has added a number of volumes to both the Herschel Special Library and the general library.

A special case to accommodate both the recently acquired sets of encyclopædias, an accession case and a filing cabinet have been added to the furnishings of the library.

An increase in the activities of the Society along various lines has been attended by a corresponding increase in clerical work, which for a time seriously handicapped the work of recataloguing the library. The pressure has been relieved, however, by the employment of an assistant, and the work is again making good progress.

Among the immediate needs of the library may be mentioned an up-to-date dictionary of the English language and a new Boston city directory. The committee recommends that these two books be purchased; also that a sum not less than one hundred dollars be appropriated for the purchase of current engineering books during the year.

Respectfully submitted,

S. E. Tinkham,
Frederic I. Winslow,
Henry F. Bryant,
Committee on Library.

Report of the Executive Committee of the Sanitary Section.

Boston, Mass., March 3, 1915.

The past year has been one of activity in the Sanitary Section. Seven meetings have been held, as follows:

March 4, 1914. — "The Collection and Treatment of Sewage in Their Relation to the City of Philadelphia," George S. Webster.

May 11, 1914. — "The Development and Present Status of Sewage Purification in England," Arthur J. Martin.

June 3, 1914. — Excursion to Fitchburg, Mass., Sewage Treatment Works.

November 27, 1914. — "The Industrial Wastes of Chicago, with Particular Reference to the Packing Industry," Langdon Pearse.

December 9, 1914. — "The Economic Depth of Trickling Filters," Harrison P. Eddy.

"A Study of Depth of Filter Material in Connection with Trickling Filter Efficiency," H. W. Clark.

January 6, 1915. — "Diatoms," F. F. Forbes and Dr. J. W. M. Bunker.

February 3, 1915. — "Garbage Disposal at Worcester, Mass.," Dr. Frederic Bonnet, Jr.

"Garbage Reduction Plants at Cleveland, Schenectady and New Bedford," W. J. Springborn.

The June excursion was held in Fitchburg and included an inspection of the sewage treatment works. The city entertained the Section at lunch and with a trolley trip to Whalom Park and Wachusett Lake. The attendance was 65.

One important piece of committee work has been accomplished in the "Toilet Regulations for Industrial Establishments," adopted by the Section December 9, 1914, and published in the February number of the Journal.

With the authority and advice of the Executive Committee, the chairman has appointed the following special committees to study and report upon:

"Methods of Design and Construction and Results of Operation of Submerged Pipe Lines for Outfall Sewers," Hiram A. Miller, chairman; DeWitt C. Webb, George A. Sampson, Edgar S. Dorr.

"Methods of Design and Construction and Results of Operation of Inverted Siphons for Carrying Sewage Only and for Storm Water," William S. Johnson, chairman; Rufus M. Whittet, Dwight Porter.

Four of the Boston meetings have been held in the Society Library, and the other two at the Engineers' Club. They have been well attended, as the following figures will show:

	Record of Attendance.	
	Dinner.	Meeting.
March (1914) annual meeting	49	80
May special meeting	25	46
June excursion	..	65
November special meeting	..	55
December meeting	..	48
January	..	56
February	..	30
Average attendance (6 meetings) not including excursion	..	53

Four new members have been added, making the present total membership of the Sanitary Section 177, of which 13 are members of the Section only, 3 are juniors and 1 an associate. There were 18 former members reinstated.

The fine projection lantern presented to the Society by Mr. John R. Freeman has proved of great value in the meetings of the Section, and because of the attachments provided it has been possible to present subjects which would otherwise have been impracticable.

Respectfully submitted for the Executive Committee,

Frank A. Marston, *Clerk.*

Report of the Committee on Social Activities.

Boston, Mass., March 17, 1915.

To the Board of Government, Boston Society of Civil Engineers:

Gentlemen, — The Committee on Social Activities, appointed by you in the spring of 1914, has the honor to report as follows:

Five informal dinners have been held during the year on June 10, October 21, November 18, and December 16, 1914, and on January 27, 1915. No informal dinner was arranged for February, 1915, on account of the annual dinner of the mechanical, electrical and civil engineers which came during that month. These dinners have always preceded regular meetings of the Society, the members attending the dinner going from there direct to the meeting.

The committee has been made up of fifteen members, and all have worked in harmony and have never failed to respond to the call of the chairman. We started out with a slogan of "A Membership of One Thousand with One Hundred Per Cent. of Good Fellowship by 1915," with the purpose of making every effort possible to bind the membership of the Society more closely together and to build up and foster a social spirit based upon that good-fellowship known best to engineers. We felt that our efforts would also tend to help out the Committee on Membership. The success of what we have tried to do must be judged by the Society.

The record of attendance at the dinners is:

Date.	Members.	Guests.	Total.
June 10	58	6	64
October 21	66	48	114
November 18	74	15	89
December 16	63	4	67
January 27	71	12	83

The average attendance was 84.

The June 10 dinner was held at the Crawford House, with Mr. Charles H. Eglee as toastmaster.

The October 21 dinner was held in Chipman Hall, with Mr. Edwin R. Olin as toastmaster. Ladies were present at this dinner.

The November 18 dinner was held at the City Club, with Mr. George A. Carpenter as toastmaster.

The December 16 dinner was held at the City Club, with Mr. Charles H. Eglee as toastmaster.

The January 27 dinner was held at the City Club, with Mr. William E. McKay as toastmaster.

Mr. Edwin R. Olin acted as choragus at all of the dinners, and the improvement in singing was very noticeable under his guidance.

The personnel of the committee was as follows: Lawrence B. Manley, George A. Carpenter, John N. Ferguson, Henry A. Symonds, Charles H. Gannett, Clarence T. Fernald, Edwin R. Olin, Frederic C. H. Eichorn, George A. Sampson, Charles H. Eglee, Herbert N. Cheney, Leslie H. Allen, Edwin D. Hayward and Harold Robinson.

Respectfully submitted for the Committee,

EDMUND M. BLAKE,

Chairman Committee on Social Activities.

REPORT OF THE EDITOR OF THE JOURNAL.

BOSTON, MASS., January 18, 1915.

TO THE BOARD OF GOVERNMENT OF THE
BOSTON SOCIETY OF CIVIL ENGINEERS:

Gentlemen, — I have the honor to submit the following report on the JOURNAL OF THE BOSTON SOCIETY OF CIVIL ENGINEERS for the year 1914.

The JOURNAL was published monthly, except in July and August, ten numbers being issued. As our Society had furnished an average of about 300 pages a year to the *Journal of the Association of Engineering Societies*, and at the same time had published the *Bulletin*, the Committee on Publications estimated, in October, 1913, that we might expect to print a total of about 760 pages a year; that we would probably use about 40 cuts and 5 inserted plates; and that the total cost would be about \$2 500 a year. Deducting the income from the amount of advertising which the *Bulletin* contained, this would correspond with a total net cost of about \$1 600.

We have considerably exceeded the estimates, having printed a total of 914 pages, with 134 cuts and 26 inserted plates, at a gross cost of \$4 285.74. The amount of advertising has been increased about 66 per cent., and the income from advertisements for the year was \$1 419.50. Deducting that amount, together with the sums received from subscriptions, sales of JOURNALS, extra reprints and cuts, the total net cost of the JOURNAL was \$2 660.93, or an average of \$266.09 per issue. From this total might also be deducted the small balance credited to us at the Post-Office, although it is practically a negligible amount.

The January number, containing 26 inserted plates, was an exceptionally costly one, \$1 227.54 having been spent on that issue alone. Neglecting this issue, the net cost was about \$1 778, or an average net cost of \$177.80 for the nine subsequent issues.

It appears therefore, that, excepting the January JOURNAL, the average net cost of publication has closely approximated the estimate made by the

Month.	Pages of				Cuts in		Cost of							
	Index.	Proc.	Papers.	Adv.	Proc.	Papers.	Papers, Proc., Index.	Cuts.	Adv'ts.	Reprints.	Postage, Wrapping, Mailing.	Editing.	Holding Type.	Adv. Comm.
Jan.		19	30	14		26	$632.50	$417.20	$45.10	$45.00	$37.74	$50.00*	(Copyright fees and Editor's Inci-dentals.)	
Feb.		9	54	14		16	172.20	16.65	15.93	32.94	13.38	25.00		
Mar.		15	94	20	1	31	292.77	51.40	35.70	37.50	14.04	25.00		
April		33	84	20	1	9	340.24	15.25	14.65	23.50	14.16	25.00		
May		16	28	20		0	140.75	8.10	24.40	14.00	14.01	25.00		
June		16	92	20		40	373.18	40.25	23.36	22.49	14.06	25.00		
Sept.		18	36	20		2	158.62	2.75	18.95	16.00	14.16	25.00		
Oct.		13	62	20		21	190.67	1.75	17.65	19.31	13.94	25.00		
Nov.		10	28	20		2	116.30	1.60	20.75	7.50	13.84	25.00		
Dec.	8	21	40	20		11	193.94	18.00	17.70	5.50	14.12	25.00		
Total	8	170	548	188	2	158	$2 611.17	$572.95	$234.19	$223.74	$163.45	$325.00	$41.59	$113.75

Total pages = 914.
Total cuts = 160.

Total cost	$4 285.74
Deduct receipts	1 624.81
Net cost	$2 660.93

*Includes December, 1913.

committee, the larger gross cost being offset by the increase in advertising receipts.

The number of pages and cuts printed, and the details of the costs, are shown in the table on preceding page.

The total number of copies of the JOURNAL mailed in December was 987. Of these, 49 went in exchange for other publications and 6 were sent to libraries. Twelve hundred copies of each number have been printed, so that a good supply of all issues is on hand.

Respectfully submitted,

EDWARD C. SHERMAN, *Editor.*

APPLICATIONS FOR MEMBERSHIP.

[April 6, 1915.]

THE By-Laws provide that the Board of Government shall consider applications for membership with reference to the eligibility of each candidate for admission and shall determine the proper grade of membership to which he is entitled.

The Board must depend largely upon the members of the Society for the information which will enable it to arrive at a just conclusion. Every member is therefore urged to communicate promptly any facts in relation to the personal character or professional reputation and experience of the candidates which will assist the Board in its consideration. Communications relating to applicants are considered by the Board as strictly confidential.

The fact that applicants give the names of certain members as reference does not necessarily mean that such members endorse the candidate.

The Board of Government will not consider applications until the expiration of twenty (20) days from the date given.

ALMY, HORACE THOMAS, Providence, R. I. (Age 33, b. Tiverton, R. I.) Had grammar school education and two years' private study. From Jan., 1899, to 1902, with F. M. Metcalf, civil engineer, New Bedford; from 1902 to 1903, with Erastus Worthington on water works and sewer design and construction; later in the same year, re-entered office of F. M. Metcalf, in charge of general engineering work; from Feb., 1913, to date, assistant engineer with Bridge Dept., Providence. Refers to F. B. Bourne, W. D. Bullock, E. W. Ross and I. S. Wood.

Bliss, Edwin Packard, Malden, Mass. (Age 43, b. Boston, Mass.) Educated in public schools of Salem and at Mass. Inst. of Technology. From 1898 to 1899, draftsman with N. E. Gas & Coke Co. on work of laying out Everett plant; 1899, draftsman on structural steel, Elevated Div., Boston Elevated Ry. Co.; from 1899 to 1900, assistant engineer with N. J. Steel & Iron Co., Boston office; from 1900 to 1902, engineer with Jones & Laughlin Steel Co., Boston office; from 1902 to date, partner in contracting engineering firm of H. P. Converse & Co. Refers to J. E. Carty, L. S. Cowles, F. H. Fay, J. N. Ferguson and F. W. Hodgdon.

Borden, James Edgar, Fall River, Mass. (Age 47, b. Fall River, Mass.) Graduate of Mass. Inst. of Technology, 1890. From 1890 to 1891, with Met. Sewerage Comm.; from 1891 to 1892, with Rumford Falls Power Development Co.; from 1892 to date, with Fall River Engrg. Dept. in various capacities; since June, 1913, has been city civil engineer. Refers to H. K. Barrows, P. D. Borden, F. H. Fay, W. E. Noble, A. L. Shaw and C. M. Spofford.

Bryant, Chauncey Davis, Newton, Mass. (Age 23, b. Chicopee, Mass.) Graduate of Mass. Inst. of Technology, sanitary engineering course, 1914. Employed as draftsman for six weeks, during summer vacation of 1914, by Metcalf & Eddy; is now employed as draftsman by Robert Spurr Weston. Refers to F. A. Marston, D. L. Porter, F. L. Preble, G. A. Sampson, C. W. Sherman and R. S. Weston.

Bullard, Albert Ovington, Sterling, Mass. (Age 41, b. West Boylston, Mass.) From Dec., 1895, to 1908, with Met. Water & Sewerage Board, as apprentice, rodman, etc., and finally as assistant engineer in charge of construction; was for several months with John R. Freeman, Providence, on reports of hydro-electric development studies in California; from 1909 to date, in general contracting work in New England. Refers to E. R. B. Allardice, N. S. Brock, R. H. Hosmer and M. J. Locke.

Burroughs, Russell, Concord, N. H. (Age 40, b. Dunbarton, N. H.) Educated in public schools of Dunbarton and Concord, N. H., and at Pembroke Academy, Pembroke, N. H. From 1892 to 1893, chainman on construction of New Boston Branch of B. & M. R. R.; from 1893 to 1899, engaged in municipal work for cities of Concord, Rochester and Somersworth, N. H.; from 1899 to 1904, resident engineer on construction of Manchester & Milford Branch and Concord and Manchester Electric Branch of B. & M. R. R.; from 1904 to 1914, assistant engineer, M. of W. Dept., B. & M. R. R.; from 1914 to date, acting division engineer, M. of W., on 2d division, B. & M. R. R. Refers to A. B. Corthell, W. B. Howe, F. W. Lang and J. W. Storrs.

Chase, Horace H., Brockton, Mass. (Age 39, b. Weymouth, Mass.) Was for nine years in city engineer's office, Brockton; is now principal assistant to F. A. Barbour, sanitary engineer, with whom he has been for eleven years; elected a member of the Sanitary Section, June 9, 1906, and now wishes to be transferred to grade of member. Refers to F. S. Bailey, F. A. Barbour, E. G. Bradbury, B. R. Felton, F. H. Snow and H. T. Stiff.

Chevalier, Charles Russell, St. Johnsbury, Vt. (Age 34, b. North Hampton, N. H.) Graduate of Hampton Academy. From June, 1899, to 1902, with B. & M. R. R. as chainman, transitman, draftsman, chief-of-party, etc.; from September, 1902, to June, 1903, transitman with N. Y. C. & H. R. R. R.; from June, 1903, to November, 1911, with N. Y., N. H. & H. R. R.; began as transitman, but was promoted to position of assistant engineer, M. of W. Dept., in 1906, and again in 1910, to position of resident engineer in charge of proposed double track tunnel at Fall River; from November, 1911, to date, with B. & M. R. R.; now holds position of division engineer, M. of W. Dept., at St. Johnsbury, Vt. Refers to S. P. Coffin, A. B. Corthell, B. W. Guppy, H. L. Ripley, B. A. Robinson and L. W. Tucker.

Clapp, Arthur Schuyler, Norfolk, Mass. (Age 33, b. Milton, Mass.) Educated in public schools. From April, 1900, to Nov., 1912, with B. & M. and N. Y., N. H. & H. railroads; from Nov., 1912, to date, in private practice as engineer and contractor. Refers to H. W. Hayes, H. C. Higgins, C. B. Humphrey, G. T. Sampson and H. L. White.

Clapp, Frank Lemuel, Boston, Mass. (Age 44, b. Boston, Mass.) Student at Mass. Agricultural College, 1892–96. From 1890 to 1892, rodman with E. W. Bowditch, Boston; from 1896 to 1901, rodman and instrumentman with Dist. Dept., Met. Water Bd., Boston; from 1901 to 1906, draftsman, assistant engineer and engineer on construction with Robert A. Cairns, city engineer, Waterbury, Conn.; from 1906 to 1914, with Board of Water Supply, City of New York; from 1914 to 1915, in private practice and with Bay State St. Ry. Co. Refers to S. D. Dodge, J. N. Ferguson, W. E. Foss, H. W. Horne and J. L. Howard.

Clapp, Frederick Otis, Providence, R. I. (Age 42, b. Providence, R. I.) Received degrees of A.B. and A.M. from Brown University in 1895 and 1897, respectively; received degree of S.B. from Mass. Inst. of Technology, 1899. From 1895 to 1897, instructor in mathematics, Brown University; from 1899 to 1902, in city engineer's office, Providence; from 1902 to 1909, in charge of construction of slow sand filtration plant for Providence Water Works; from 1909 to date, in city engineer's office, on miscelianeous work connected with water and sewer department. Refers to C. F. Allen, J. W. Bugbee, W. D. Bullock, O. F. Clapp, H. P. Eddy, Dwight Porter, G. F. Swain and I. S. Wood.

Clark, Frederick Howe, Springfield, Mass. (Age 47, b. Northfield, Vt.) Graduate of Norwich University, degree of B.C.E., 1889. From 1889 to 1900, with Engineering Dept. of City of Worcester, Mass.; from 1900 to 1908, engineer in charge of reservoir construction, Water Dept., Worcester; from 1908 to 1910, first assistant to city engineer, Worcester; from 1910 to 1913, street commissioner of Worcester; from 1913 to date, superintendent of streets and engineering, Springfield. Refers to Joshua Atwood, A. W. Dean, H. P. Eddy, L. K. Rourke and D. C. Webb.

Collins, Harry Bumstead, Brookline, Mass. (Age 25, b. Gloucester, Mass.) Student in hydraulics and reinforced concrete at Boston Y. M. C. A.

and Franklin Union; has passed civil service examination for senior transitman. During summers of 1906–1909, with Brookline Engineering Dept.; from 1910 to date, with Brookline Engineering Dept. as senior transitman. Refers to H. F. Bryant, F. F. Forbes, H. W. French, F. A. Leavitt, H. A. Varney and C. J. Wallace.

DEMING, GUY SPALDING, Lowell, Mass. (Age 27, b. New York, N. Y.) Graduate of Harvard College, 1910, with degree of A.B.; student for two years at Graduate School of Applied Science, Harvard University, civil engineering course. During summers of 1910 and 1911, assistant instructor in plane and railroad surveying at Harvard Engineering Camp; from June, 1912, to date, assistant to Arthur T. Safford, consulting hydraulic engineer, Lowell, in his consulting work and conduct of course on Water Power Engineering at Graduate School of Applied Science, Harvard University; is now resident engineer in charge of construction, slow sand filter plant, Gardiner, Me. Refers to H. J. Hughes, L. J. Johnson, G. W. Mansur and A. T. Safford.

DENLEY, ALFRED N., Winchester, Mass. (Age 28, b. Rockland, Mass.) Student at Rindge Manual Training High School, Cambridge, 1906; student at Lowell Inst., in mechanical engineering course, 1908, and in electrical courses, 1909. From 1906 to 1907, draftsman with Blake & Knowles Pump Works, Cambridge; from 1907 to 1909, draftsman with C. H. Tenney Co., Boston; from 1909 to 1915, draftsman and resident engineer with Chas. T. Main. Refers to F. M. Gunby, J. F. Osborn, H. L. Robinson, H. E. Sawtell and W. F. Uhl.

DEVINE, WALTER A., Randolph, Mass. (Age 27, b. Randolph, Mass.) Received public school education; also attended Thayer Academy for one year and took one-year structural course at Franklin Union. From April, 1906, to date, with Engineering Dept., Brookline, Mass., on design and construction work. Refers to F. F. Forbes, H. W. French, F. A. Leavitt, E. H. Rockwell, H. A. Varney and C. J. Wallace.

DONOVAN, FREDERICK PHILOMEN, Roxbury, Mass. (Age 24, b. Boston, Mass.) Graduate of Harvard College, 1911; student at Harvard Graduate School of Engineering, 1912. From 1912 to date, engineer with Hugh Nawn Contracting Co. Refers to S. T. Connolly, F. C. H. Eichorn, J. T. Frame, G. W. Lewis and Hugh Nawn.

DURANT, WILLIAM B., Turners Falls, Mass. (Age 25, b. Cambridge, Mass.) Student at Harvard College, 1906 to 1909, and at Harvard Graduate School of Applied Science, 1909 to 1910, civil engineering course. From 1910 to 1911, with N. Y., N. H. & H. R. R., as surveyor and inspector; from 1911 to date, engineer with Turners Falls Co., on dam design and canal excavation. Refers to H. J. Hughes, H. A. Moody, A. T. Safford and H. D. Woods.

FARWELL, JOSEPH WILLARD, Jr., Canton, Mass. (Age 25, b. Millis, Mass.) Student at Mass. Inst. of Technology, 1908 to 1910. From Sept., 1910, to June, 1913, with Maintenance of Way Dept., N. Y., N. H. & H. R. R., chiefly as rodman, but as assistant draftsman during last three months; from

June, 1913, to Aug., 1914, in private business; from Aug. to Nov., 1914, inspector with Duxbury Fire & Water District; from Nov., 1914, to date, transitman with Maintenance of Way Dept., N. Y., N. H. & H. R. R. Refers to L. H. Allen, J. N. Ferguson, C. V. Reynolds, G. T. Sampson and A. S. Tuttle.

FOSTER, HARRY C., Gloucester, Mass. (Age 43, b. Swampscott, Mass.) Received education in Gloucester public schools and from special course at Mass. Inst. of Technology, 1893. From 1893 to 1905, with Boston Street Commissioners, in charge of division for six years; in business for two years under firm name of Sellew & Foster; with Boston Consolidated Gas Co., in charge of construction of gas holder for one year; with Boston Elevated Ry. Co., street laying-out division, for six years. Refers to Clifford Foss, C. B. Humphrey, C. F. Knowlton, H. C. Mildram, A. L. Plimpton, E. H. Rogers, F. E. Sherry and F. O. Whitney.

FOWLER, SAMUEL JONES, Cambridge, Mass. (Age 64, b. Westfield, Mass.) Educated at Westfield High, Normal and Academy; also at Dresden and Jena, Germany, and Liége, Belgium. Has served as general chemist for Laflin & Rand Powder Co., expert for Rendrock Powder Co., designer for Riverside Worsted Mills, treasurer of Westfield Gas Co., and manager of Springfield Gas Co.; is now treasurer and agent for Charlestown Gas & Electric Co. Refers to H. N. Cheney, J. W. Ellis, F. H. Fay, N. W. Gifford, J. A. Gould, W. E. McKay, I. E. Moultrop, Hugh Nawn and S. E. Tinkham.

GAGE, STEPHEN DEMERITTE, Providence, R. I. (Age 41, b. Durham, N. H.) Graduate of Mass. Inst. of Technology, 1896. From July, 1896, to May, 1914, with Mass. State Board of Health at Lawrence Experiment Station; was biologist and principal assistant during greater portion of this time; from June, 1914, to date, chemist and sanitary engineer to Rhode Island State Board of Health; elected a member of Sanitary Section, March 2, 1904, and now wishes to be transferred to grade of member. Refers to G. A. Carpenter, H. W. Clark, H. P. Eddy, R. A. Hale, A. D. Marble and R. S. Weston.

GIBLIN, JOHN FRANCIS ALOYSIUS, Boston, Mass. (Age 25, b. Boston, Mass.) Graduate of Harvard College with degree of A.B., 1911; student in Graduate School of Applied Science, Harvard College, 1910–1911; student in building course, Lowell Inst., 1914–15. From June to Oct., 1911, and from July to Sept., 1912, rodman and draftsman with Sewer Div., Public Works Dept.; from Sept., 1912, to date, assistant with Boston Transit Comm. Refers to F. C. H. Eichorn, G. D. Emerson, J. A. McMurray, P. H. Mosher, Hugh Nawn and J. M. Shea.

HARTY, JOHN JOSEPH, Jr., Boston, Mass. (Age 25, b. Greenville, Miss.) Student at Mass. Inst. of Technology, 1910–13. From June, 1906, to Sept., 1910, with J. J. Harty, general contractor, Greenville, Miss.; from June to Sept., 1912, with N. E. Concrete Construction Co., Boston; from June, 1913, to Sept., 1914, with Monks & Johnson, engineers and architects, Boston; from Nov., 1914, to date, with Fay, Spofford & Thorndike, consult-

ing engineers, Boston. Refers to F. H. Fay, Mark Linenthal, J. R. Nichols, C. M. Spofford and S. H. Thorndike.

HORNE, RALPH WARREN, Malden, Mass. (Age 26, b. Malden, Mass.) Graduate of Mass. Inst. of Technology, 1910. Assistant at Mass. Inst. of Technology, during collegiate year of 1911; from 1911 to 1915, assistant engineer and designer for Metcalf & Eddy; at present employed by Fay, Spofford & Thorndike. Refers to H. P. Eddy, F. H. Fay, Leonard Metcalf, C. W. Sherman, C. M. Spofford and S. H. Thorndike.

JOY, CHARLES FREDERICK, Jr., Fall River, Mass. (Age 28, b. Chelsea, Mass.) Graduate of Mass. Inst. of Technology, civil engineering course, 1910. During summer of 1909, timekeeper and material man with J. W. Bishop Co.; with B. & M. R. R., M. of W. Dept., for about nine months; from Jan. to March, 1912, assistant engineer on Neponset River preliminary surveys; from April to Dec., 1912, inspector of sewer construction, Attleboro, Mass.; from Jan. to April, 1913, assistant engineer and draftsman with Bay State St. Ry. Co., at Newport, R. I.; from May, 1913, to May, 1914, assistant engineer on Neponset River Improvement; from May to Dec., 1914, resident engineer on construction of sewage disposal plant for Franklin, Mass.; is now with Hanscom Construction Co., as engineer on construction of intercepting drain at Fall River, Mass. Refers to E. M. Blake, N. L. Hammond, Dwight Porter, A. L. Shaw, C. M. Spofford and J. J. Van Valkenburgh.

LAMSON, JOHN STEVENS, Arlington, Mass. (Age 49, b. Cambridge, Mass.) Graduate of Tufts College, civil engineering course, 1889. From 1889 to 1891, taught at Tufts College; from 1891 to March, 1914, with City of Boston, first in city engineer's office and later in Public Works Dept.; from Sept., 1914, to date, with Fay, Spofford & Thorndike. Refers to M. T. Cook, E. W. Howe, Theodore Parker, C. M. Spofford and S. H. Thorndike.

LANGDON, GEORGE WOODWARD, Jr., Brookline, Mass. (Age 26, b. Clinton, Mass.) Graduate of Newburyport High School, 1908; student at Brown Univ., 1908 to 1912. During summers of 1908 and 1909, engineer in connection with auxiliary water supply, City of Newburyport; engineer on land development scheme in Rhode Island for two months in 1912; from June, 1913, to Feb., 1914, resident engineer with Mass. Highway Comm. on construction in Wellesley and Natick and on construction of concrete bridge at Tyngsboro; since Feb., 1914, has been engaged in non-technical work; is now assistant general manager of Keystone Stoker Co. Refers to J. B. Blood, H. B. Drowne, Harold Parker, A. E. Tarbell and L. D. Thorpe.

LEARY, HERBERT DANIEL, East Boston, Mass. (Age 28, b. East Boston, Mass.) Graduate of Mechanic Arts High School, 1904; took post-graduate course, 1905; student at Tufts College, 1906, and at University of Maine, 1907, civil engineering course. From June, 1910, to July, 1911, engineering inspector with Mass. Highway Comm.; from July, 1911, to April, 1913, with Lucius Engineering Co., Pittsburgh, Pa., as engineer and estimator on railroad bridge construction; from April, 1913, to May, 1914,

with Turners Falls Co. on large hydro-electric development; from May, 1914, to date, with Boston Transit Comm. Refers to E. S. Davis, F. C. H. Eichorn, G. D. Emerson and J. T. Frame.

LYNCH, ARTHUR VINCENT, Boston, Mass. (Age 27, b. Boston, Mass.) Graduate of Mechanic Arts High School; student at Y. M. C. A. evening school for two years and at Franklin Union for three years. With French & Bryant, engineers, for one year; has been seven years with Boston Transit Comm., as inspector and transitman. Refers to C. L. Brown, W. W. Davis, G. D. Emerson, B. A. Rich and P. B. Walker.

MCMULLEN, ERNEST WILLIAM, Jamaica Plain, Mass. (Age 25, b. Boston, Mass.) Graduate of Mechanic Arts High School, 1908; has taken courses at Y. M. C. A. evening school. From 1908 to 1911, with Francis W. Wilson, consulting engineer, on concrete design and in charge of drafting room; from 1911 to date, with Monks & Johnson; has served as resident inspector on buildings and is now in charge of squad of men working on design of concrete building. Refers to Randolph Bainbridge, Granville Johnson, Mark Linenthal and J. R. Nichols.

MAWNEY, ROBERT WHEATON, Pittsfield, Mass. (Age 35, b. East Greenwich, R. I.) Student at Brown Univ., civil engineering course, 1900 to 1904. During college course worked for Ernest H. Brownell, C.E., and Samuel M. Gray, C.E., both of Providence; from 1905 to 1906, with steam heating firm in Providence; from 1906 to 1907, with Lockwood, Greene & Co., on water-power development and surveys in North and South Carolina and in Georgia; from 1907 to 1909, draftsman with Charles River Basin Comm.; from 1909 to date, assistant engineer with City of Pittsfield, chief work in this capacity having been on design of water works and bridges. Refers to T. F. Dorsey, R. W. Emerson, A. A. Fobes, H. A. Miller and E. C. Sherman.

MAYNARD, ARTHUR J., State Farm, Mass. (Age 46, b. Fall River, Mass.) Educated in public schools. During year 1886, timekeeper and foreman with Brightman & Place; from 1887 to 1889, superintendent of building construction with Beattie & Wilcox; from 1889 to date, superintendent of construction at Massachusetts State Farm; has built 95 per cent. of State Farm buildings. Refers to H. B. Andrews, W. M. Bailey, E. S. Larned, E. F. Rockwood, S. E. Thompson and L. C. Wason.

MILLER, BUCKINGHAM, Newton Highlands, Mass. (Age 26, b. Des Moines, Ia.) Graduate of Newton High School, 1906; student for three years at Yale College. Previous to Sept., 1910, worked five summers as rodman; from Sept., 1910, to Jan., 1912, rodman and instrumentman for MacArthur Bros. Co. and Winston & Co., at Ashokan Dam; Jan. to June, 1912, assistant engineer, Board of Water Supply of New York City, on city aqueduct tunnel; from June, 1912, to Sept., 1914, chief-of-party and inspector for Directors of Port of Boston; Sept. to Dec., 1914, assistant engineer with Percy M. Blake on Mansfield water supply construction. Refers to J. N. Ferguson, F. W. Hodgdon, J. L. Howard and H. A. Miller.

Morrill, Fred William, West Roxbury, Mass. (Age 30, b. Haverhill, Mass.) Graduate of Mass. Inst. of Technology, 1907, civil engineering course. During year 1907–08, with contracting company on construction work and later acted as inspector on bridge; from June, 1908, to June, 1911, taught railroad and bridge engineering at Pei Yang Univ., Tientsin, China; from Oct. to Dec., 1911, with New York Central Ry. on valuation work; from Dec., 1911, to Feb., 1914, designer and concrete inspector with J. R. Worcester & Co.; in Feb., 1914, entered employ of Quequechan River Comm., Fall River; is now employed by Fay, Spofford & Thorndike, on design of concrete structures for proposed improvement of Quequechan River. Refers to F. H. Fay, H. F. Sawtelle, C. M. Spofford and S. H. Thorndike.

O'Connor, James Henry, Roslindale, Mass. (Age 27, b. Holliston, Mass.) Student at Harvard College, 1907–08. From 1910 to 1911, rodman with Public Works Dept., City of Boston; from 1911 to 1912, draftsman, High Pressure Fire Service, Boston; from 1912 to date, assistant with Boston Transit Comm. Refers to F. C. H. Eichorn, L. B. Manley, C. V. Reynolds and R. E. Rice.

Parke, Robert Heywood, Fitchburg, Mass. (Age 39, b. Monson, Mass.) Graduate of Tufts College, 1898, with degree of B.S. in electrical engineering; received degree of M.S. from Tufts, 1903. Entered employ of Fitchburg R. R., Sept., 1899, as transitman; within a year was advanced to engineer's assistant in charge of construction of new dock between U. S. Navy Yard and Railroad Pier 7, Charlestown; was for several years in charge of surveys and construction work on different divisions of B. & M. R. R.; transferred to Fitchburg, in charge of division office, 1903; in charge of division office, Greenfield, from 1906 to 1912; from 1912 to date, assistant engineer, maintenance of way department, with headquarters at Fitchburg. Refers to H. Bissell, A. B. Corthell, H. T. Gerrish, B. W. Guppy, L. C. Lawton, F. B. Rowell and J. P. Snow.

Putnam, Harold W., Lynn, Mass. (Age 22, b. Lynn, Mass.) Student at Boston Y. M. C. A. Co-operative Engineering School, 1911 to 1913. From Nov., 1912, to June, 1914, with Aspinwall & Lincoln; from June to Dec., 1914, with Mass. Highway Comm.; from March, 1915, to date, with Metropolitan Park Comm. Refers to Thomas Aspinwall, H. P. Burden, J. N. Ferguson, E. H. Lincoln, F. D. Sabin and T. W. Souther.

Rhodes, Ralph Farnham, Newport, R. I. (Age 35, b. Meadville, Miss.) Received degree of B.S. in 1900 and degree of C.E. in 1901 from Louisiana State University. From 1901 to 1904, track apprentice, chainman, rodman, and instrumentman with Y. & M. V. R. R.; in 1904, chief-of-party on preliminary railroad surveys in Louisiana and Mississippi; from 1904 to 1905, engineer for Park Comm., Memphis, Tenn.; from 1905 to 1907, superintendent for contractor on levee and canal construction; in 1907, resident engineer in charge of railway construction in Mississippi, and chief-of-party on survey of islands in Mississippi River; in 1908, in charge of highway bridge construction in Mississippi; in 1909, in charge of survey

of timber land in Louisiana; from 1909 to date, with U. S. Engr. Dept., Newport, R. I.; since 1913 has held position of junior engineer; holds license to practice as civil engineer in Louisiana. Refers to A. S. Ackerman, J. R. Burke, T. G. Hazard, Jr., S. A. Miller, A. J. Ober and M. T. Whiting.

Richmond, Carl Gee, Revere, Mass. (Age 26, b. Peabody, Mass.) Graduate of Mass. Inst. of Technology, 1911. From June, 1910, to Jan., 1915, with Engineering Dept. of Mass. Highway Comm., on survey, office and construction work; from Jan., 1915, to date, city engineer and superintendent public works, Revere, Mass. Refers to C. F. Allen, A. W. Dean, E. R. Hyde, G. P. Soutar, C. M. Spofford, A. T. Sprague and C. S. Tinkham.

Robbins, Henry C., Newton Highlands, Mass. (Age 38, b. Westbrook, Me.) Special student of architecture, Harvard Univ., 1897–98. Was for seven years chief draftsman with Warren, Smith & Biscoe; was for two years architect with American Tel. & Tel. Co.; was for seven and a half years architect with Densmore & LeClear; since July, 1914, member of firm of Densmore & LeClear. Refers to G. H. Brazer, C. R. Gow, L. L. Street and L. C. Wason.

Rooks, Clarence Henry, Lawrence, Mass. (Age 51, b. Clifton, Me.) Educated in public schools, Clifton and Amherst, Me. From 1887 to 1888, with Mass. State Board of Health at Lawrence Experimental Station; from 1888 to date, with Essex Co. nearly continuously, as assistant engineer on hydraulic matters; in 1902 was with John R. Freeman on Charles River Dam investigation. Refers to J. R. Baldwin, F. H. Carter, R. A. Hale, C. T. Main, A. D. Marble, A. F. Safford and W. E. Spear.

Simmons, John Edgar, Wollaston, Mass. (Age 32, b. Wollaston, Mass. Graduate of Mechanic Arts High School, 1901; took postgraduate course, 1902; student at Mass. Inst. of Technology, 1902–05. From 1905 to 1906, foreman, Swift Soap Works, Somerville; from 1906 to 1912, superintendent, Flash Chemical Co., Boston; from March, 1912, to date, draftsman and estimator, Simpson Bros. Corp., Boston. Refers to H. B. Andrews, E. C. Hultman, D. P. Kelley, C. F. Knowlton and E. C. Sargent.

Webb, George Fuller, Bellows Falls, Vt. (Age 40, b. Bellows Falls, Vt.) Received common school education in public schools of Bellows Falls; since August, 1908, student with International Correspondence Schools, complete engineering course. From April, 1910, to December, 1912, with New Hampshire State Highway Dept.; during season of 1913, with Lane Construction Corp'n, Meriden, Conn., on highway construction; from 1913 to date, engaged in contract and engineering work, lately for B. A. Robinson, C.E., Bellows Falls. Refers to C. M. Brooks, A. W. Dean, H. B. Drowne and B. A. Robinson.

Whitmore, Harold Cushing, Lynn, Mass. (Age 28, b. Lynn, Mass.) Graduate of Dartmouth College, 1909, degree of B.S. From April, 1909, to July, 1910, rodman and instrumentman on Charles River Dam; from July to Dec., 1910, instrumentman with Mass. Harbor and Land Comm.; from Dec., 1910, to Aug., 1912, instrumentman and chief-of-party on Farnham

Dam, city of Pittsfield water supply; from Aug., 1912, to March, 1914, chief of-party on dam at Somerset, Vt., for Power Construction Co. of Shelburne Falls; office assistant with same company in main office at Shelburne Falls from March to Oct., 1914. Refers to W. N. Charles, T. F. Dorsey, J. N. Ferguson, J. L. Howard, H. A. Miller and C. F. Powers.

Whitney, Harry L., Somerville, Mass. (Age 52, b. Dublin, N. H.) Educated in public schools of Fitchburg, Mass. Has been connected with subway construction in Boston and Cambridge since 1906; in 1910, foreman on bridge and grade-crossing work for Coughlan & Shields; in 1911, foreman on finish construction, Section 2, Beacon Hill Tunnel; in 1912, foreman in charge of form work, Section A, Dorchester Tunnel; since Feb., 1913, superintendent at Cypher St. stock yards of Boston Transit Comm. Refers to H. C. DeLong, G. D. Emerson, L. B. Manley and P. B. Walker.

Williams, Frederick Crawford, Newport, R. I. (Age 25, b. Pawtucket, R. I.) Student at Brown Univ. from 1909 to 1913, civil engineering course. From June, 1907, to July, 1913, with City Engineer's Dept., Pawtucket, R. I., as field and office assistant, working summers and afternoons; from Nov., 1912, to Feb., 1913, worked evenings as draftsman with J. R. Freeman; from July, 1913, to date, transitman and draftsman with U. S. Engr. Dept., Newport, R. I. Refers to B. C. Bussey, G. A. Carpenter, A. J. Ober, E. S. Patton and F. A. Sweet.

LIST OF MEMBERS.

ADDITIONS.

Ackerson, Herbert N.	149 Independence Ave., Quincy, Mass.
Appleton, Arthur B.	15 Dane St., Beverly, Mass.
Barrett, Robert E.	Framingham, Mass.
Brown, William A.	87 Homer St., East Boston, Mass.
Buckley, William J.	26 Lyman St., Lynn, Mass.
Cherry, Martin C.	22 Seymour St., Roslindale, Mass.
Cochran, William J.	117 Hancock St., Dorchester, Mass.
Cowles, M. Warren	137 Newbury St., Boston, Mass.
Dolliver, Henry F.	12 Pearl St., Lawrence, Mass.
Duffy, J. Henry	42 Cogswell Ave., Cambridge, Mass.
Eisnor, John J.	42 West Newton St., Boston, Mass.
Fuller, Philip E.	Thorndike, Mass.
Griffin, John H.	Gloucester, Mass.
Hall, Charles Loring	533 West Park St., Dorchester, Mass.
Hammond, N. LeRoy	30 Walker St., Newtonville, Mass.
Harris, Gilbert M.	201 Newtonville Ave., Newton, Mass.
Hunter, Harry G.	Walpole, Mass.
King, Arthur C.	71 Colton St., Springfield, Mass.
Kirkpatrick, Charles D.	60 Federal St., Boston, Mass.

Lampie, Abraham L. .... 41 Lindsay St., Dorchester, Mass.
Miller, Charles A. .... 11 Wayland St., Wollaston, Mass.
Perley, Lew K. .... Laconia, N. H.
Perry, Chauncy R. .... Worcester Lane, Waltham, Mass.
Proctor, Fred W. .... North Adams, Mass.
Raymond, John W., Jr. .... 101 Balch St., Beverly, Mass.
Smulski, Edward .... 141 Milk St., Boston, Mass.
Stuart, George E. .... 122 Cabot Park, Newton, Mass.
Stucklen, Carl L. .... 26 Esmond St., Dorchester, Mass.
Sumner, Merton R. .... 135 Dutcher St., Hopedale, Mass.

CHANGES OF ADDRESS.

Babcock, Paul A. .... 493 Commercial St., Portland, Me.
Berry, Charles R. .... 81 Huntington Ave., Roslindale, Mass.
Bessey, Roy F. .... Care of U. S. Reclamation Service, Provo, Utah
Dotten, William J. .... 847 Fellsway, Medford, Mass.
Ellis, William H., Jr. .... 479 Meridian St., East Boston, Mass.
Hammond, Wilberforce B. .... 60 Fenway, Boston, Mass.
Hunter, William B. .... 116 Saratoga Ave., Yonkers, N. Y.
Hurd, Stephen P. .... 1900 Euclid Ave., Room 601, Cleveland, Ohio
McConnell, Ira W. .... Care of John Ware, Downey, Ida.
Milne, A. P. .... 689 Northrup St., Portland, Ore.
Monoghan, James F. .... 79 Milk St., Boston, Mass.
Sabin, Fred D. .... 14 Haskell St., Cambridge, Mass.
Simons, George W., Jr. .... 59 Astor St., Suite 15, Boston, Mass.
Smith, Sidney .... 84 Hastings St., West Roxbury, Mass.
Tinkham, Charles S. .... 24 Pond St., Greenfield, Mass.
Wilson, Albert O. .... 137 Winsor Ave., Watertown, Mass.

DEATH.

Rich, Isaac .... Died March 11, 1915

RESIGNATIONS.

(In effect March 17, 1915.)

Cunningham, J. Earl
Davis, Charles H.
Eaton, J. Haworth
Farwell, Howard L.
Harrison, Howard G.
Heald, Simpson C.
Heath, Arnold W.
Knowlton, Edgar
Manahan, Elmer G.
Murray, Frederic L.
Olmsted, Herbert W.
Peters, Anthony W.
Polleys, William V.
Saville, Charles
Shailer, Robert A.
Stetson, Charles E. F.
Walworth, Arthur C.
Willard, Ernest C.
Yates, Sheldon S.

EMPLOYMENT BUREAU.

THE Board of Government maintains an employment bureau for the Society, to be a medium for securing positions for its members and applicants for membership, and also for furnishing employees to members and others desiring men capable of filling responsible positions.

At the Society room two lists are kept on file, one of *positions available* and the other of *men available*, giving in each case detailed information in relation thereto.

MEN AVAILABLE.

297. Age 29. Student for one year at Dartmouth College. Has had more than ten years' experience, including three years as rodman and transitman with Met. Park Comm.; more than six years engineering work in Cuba, chiefly as assistant or resident engineer on railroad and street railway construction and maintenance; six months drafting on municipal work and nine months as assistant engineer in charge of construction and enlargement of water works. Desires position as engineer on survey or construction work.

298. Age 26. Graduate of Tufts College, 1911, with degree of B.S. in structural engineering. Has had more than a year's experience in detailing and designing of structural steel and three years' experience as structural engineer with Electric Illuminating Co. Desires position with engineer or contractor, in or near Boston, as designer or detailer on steel, reinforced concrete or masonry.

299. Age 25. Graduate of Mechanic Arts High School; student for one year at Harvard University and for three years at Franklin Union; has also taken I. C. S. course in municipal engineering. Has had about five years' experience, chiefly as rodman, draftsman and inspector on railroad and street railway work and on subway construction.

300. Age 23. Graduate of Mechanic Arts High School, 1910; is now student in structural course at Lowell Inst. Has had more than three years' experience as draftsman, including one and one-half years' with the Edison Electric Illuminating Co.; eight months with General Electric Co. of Lynn; seven months with Swift & Co., in construction department. Desires position as draftsman or on outside work.

301. Age 34. Graduate of Mechanic Arts High School, 1900. Has had about fifteen years' experience, including four years on landscape engineering; six years as civil engineer and draftsman, chiefly on railroad work, and about five years as mechanical draftsman and engineer for electric and hydraulic companies. Desires position as civil or mechanical engineer. Salary desired, $20 per week.

302. Age 62. Has worked continuously with Boston firm on esti-

mating and designing of structural and ornamental iron work. Desires position as structural engineer.

303. Age 29. Graduate of University of Maine, 1911, with degree of B.S. in civil engineering. Has had experience as rodman, inspector, transitman, etc., on electric railway construction and on reinforced concrete construction work; assistant engineer for industrial plant and designer and draftsman on mechanical engineering work Desires position as assistant engineer in field or assistant to designer in office. Salary desired, $125 per month.

304. Age 27. Graduate of Valparaiso University, Indiana, with degree of B.C.E. Has had one year's experience as transitman with B. & M. R. R.; three and one-half years' experience as assistant engineer for the estates of Long Beach, N. Y.; latter work included inspecting, surveying, and computing for hydraulic dredging, brick and macadam streets, water and gas mains, sewer mains and disposal plant, etc. Desires position as assistant or transitman. Salary desired, $100 per month.

LIBRARY NOTES.

Recent Additions to the Library.

U. S. Government Reports.

Annual Report of Chief of Weather Bureau for 1913–14.

Arguments for and against Train-Crew Legislation.

Eastern Hemlock. E. H. Frothingham.

Elliston Phosphate Field, Montana. R. W. Stone and C. A. Bonine.

Forest Planting in Eastern United States. C. R. Tillotson.

Hand Firing Soft Coal under Power-Plant Boilers. Henry Kreisinger.

Salines in Owens, Searles and Panamint Basins, Southeastern California. Hoyt S. Gale.

Water-Supply Paper 330.

State Reports.

Connecticut. Report of State Board of Health on Investigation of Pollution of Streams, 1914; House Bill No. 306, Act concerning Pollution of Water Supplies; House Bill No. 308, Act concerning Disposal of Sewage in Inland and Tidal Waters.

New Jersey. Mineral Industry for 1913. M. W. Twitchell.

Municipal Reports.

Belmont, Mass. Annual Report of Water Commissioners for 1914.

Brookline, Mass. Annual Report of Water Board for 1914.

Chicago, Ill. Report on Official Duty Test of Booster Pumps at Roseland Pumping Station.

Concord, Mass. Annual Report of Board of Health for 1914.

Concord, Mass. Annual Report of Road Commissioners for 1914.

Concord, Mass. Annual Report of Water and Sewer Commissioners for 1914.

Fitchburg, Mass. Annual Report of City Engineer for 1914.

Hartford, Conn. Annual Report of Water Commissioners for 1913–14.

Laconia, N. H. Annual Reports of Board of Public Works for 1914.

Leominster, Mass. Annual Report of Water Board for 1914.

New Bedford, Mass. Annual Report of Water Board for 1914.

North Adams, Mass. Annual Reports of City Officers for 1914.

Peabody, Mass. Annual Report of Commission of Public Works for 1914.

Plymouth, Mass. Annual Report of Water Commissioners for 1914.

Reading, Mass. Annual Report of Water Commissioners for 1914.

Rutland, Vt. Annual Report of City Officers for 1914.

Springfield, Mass. Annual Report of Water Commissioners for 1914.

Watertown, Mass. Annual Report of Town Officers for 1914.

Westfield, Mass. Annual Report of Municipal Light Board for 1914.

Miscellaneous.

C. L. Berger & Sons: Standard Instruments of Precision, 1915.

Carbolineum Wood Preserving Co.: Bulletins 33 and 36.

Construction of Masonry Dams. Chester W. Smith.

Designing and Detailing of Simple Steel Structures. Clyde T. Morris.

Dry Rot in Factory Timbers. Associated Factory Mutual Fire Insurance Companies.

Earth Work and Its Cost. Halbert P. Gillette.

Freight Terminals and Trains. John A. Droege.

Kearney & Trecker Co.: Milwaukee Milling Machines: Catalogue No. 19.

Modern British Permanent Way. Cecil J. Allen. Gift of Leslie H. Allen.

Preservation of Structural Timber. Howard F. Weiss.

Price of Inefficiency. Frank Koester.

Reinforced Concrete. John P. Brooks.

Reinforced Concrete Construction, 2 vols. George A. Hool.

Water Supply of Country Houses. William Paul Gerhard. Gift of author.

LIBRARY COMMITTEE.

NEW ENGINEERING WORK.

(Under this head a brief description of new engineering work contemplated or under construction will be presented each month. Engineers and contractors are requested to send descriptions of their work to the Secretary, 715 Tremont Temple, Boston, before 1st of each month.)

Commonwealth of Massachusetts. — METROPOLITAN WATER AND SEWERAGE BOARD. — *Sewerage Works.* — Surveys for the extension of the Metropolitan sewer to Wellesley have been started.

METROPOLITAN PARK COMMISSION. — *Furnace Brook Parkway.* — Bids have been received for building Furnace Brook Parkway from Quincy Shore Reservation to Hancock St., Quincy.

This work calls for about 40 000 cu. yds. of earth grading and furnishing of about 100 000 cu. yds. of filling. The lowest bidder is John Cashman & Sons Company.

Middlesex Fells Parkway. — Work of rebuilding the northerly half of Wellington Bridge, with reinforced concrete girder construction, is in progress. Coleman Brothers, contractors.

Mystic Valley Parkway. — Work of constructing parkway from Craddock Bridge to Mystic Ave. is in progress. Coleman Brothers, contractors.

General. — Considerable work is in progress throughout the reservations and parkways, undertaken with a view to relieving the conditions of unemployment.

DIRECTORS OF THE PORT OF BOSTON. — *Bulkheads.* — The wooden bulkheads adjoining the site of the proposed dry dock at the South Boston Flats are practically completed, making a total length of 10 305 lin. ft., of which 7 277.4 lin. ft. is composed of oak piles and sheeting 4 in. thick, and the remainder is of yellow pine piles with sheeting 6 in. thick.

Dredging. — The dredging of the Reserved Channel at South Boston east of the temporary entrance by the suction dredge *Tampa* has continued, making 30 ft. at mean low water in a channel 300 ft. wide. The dredging of the Reserved Channel in South Boston between L St. bridge and the temporary entrance is being done by J. P. O'Riorden's dredge No. 8 and is about 75 per cent. completed. Dredging is in progress at the site of Commonwealth Pier 1, East Boston, by the Bay State Dredging Company, making 40 ft. at mean low water.

Boston Transit Commission. — *Dorchester Tunnel.* — The Dorchester Tunnel is substantially completed from Tremont St. to the westerly side of Dewey Sq., including the Washington station.

Section D includes a station under Dewey Sq. and about 450 ft. of tunnel under Summer St. east of the station. Work is now in progress on both station and tunnel. The Hugh Nawn Contracting Co. is the contractor.

Section E includes two single-track circular tunnels which will extend from near the junction of Summer St. and Dorchester

Ave. under the Fort Point Channel and private property to a point near Dorchester Ave. between West First and West Second Sts., South Boston. These tunnels will be driven by means of shields and with compressed air. Work is in progress at the main shaft in West First St. and on the power plant. P. McGovern & Co. is the contractor.

Section H is located in Dorchester Ave. between Old Colony Ave. and Woodward St., and is about 2 200 ft. long. The structure is to be mainly of reinforced concrete, and consists of a double-track tunnel to be built by the cut-and-cover method. The work also includes a pump well, an emergency exit, and sewer changes. The T. A. Gillespie Co. is the contractor.

Enlargement of Park Street Station. — A brief description of the work for the enlargement of Park St. station was given in the December issue of the JOURNAL. The work of enlarging the station proper is now completed except the interior finish of the roof of the enlargement. The surface of the Common is being restored and the granolithic walks are being rebuilt.

Work is now in progress at the junction of Park and Tremont Sts. on removing the triangular core of earth and a part of the walls and roof and removing some of the columns of the present structure at that place and substituting new construction. Coleman Bros. are the contractors.

East Boston Tunnel Extension. — The tunnel extension has been completed with the exception of the interior finish of the two stations located under and near the present Scollay Sq. station and under Bowdoin Sq. respectively, and also with the exception of their stairways, entrances and exits. Work on the interior finish and on the stairways is in progress. In Court St. near the Ames Bldg. the invert of the East Boston Tunnel is being removed and the earth underneath excavated to the new grade.

City of Boston. — PUBLIC WORKS DEPARTMENT, HIGHWAY DIVISION, PAVING SERVICE. — Work is in progress on the following streets:

Bourneside St.,	Park St. to Melville Ave.	Bituminous macadam.
Westmoreland St.,	Adams St., about 708 ft. westerly.	Bituminous macadam.
Paisley Park,	Bourneside St. to Upland Ave.	Bituminous macadam.

Spring St.,	Gardner St. to Webster St.	Bituminous macadam.
Seaver St.,	Humboldt Ave. to Blue Hill Ave.	Excavating and grading.
Seaver St.,	Walnut Ave. to Humboldt Ave.	Excavating and grading.
St. Andrew Rd.,	Bayswater St. to Washburn Ave.	Bituminous macadam.
Intervale St.,	Columbia Rd. to Normandy St.	Bituminous macadam.
Fabyan St.,	Blue Hill Ave. to Harvard St.	Asphalt pavement.
Deering Rd.,	Blue Hill Ave. to Harvard St.	Bituminous macadam.
Temple St.,	Spring St. to Ivory St.	Excavating and grading.
Philbrick St.,	Neponset Ave. to Jewett St.	Bituminous macadam.
Ronald St.,	Brinsley St., about 263 ft. easterly.	Bituminous macadam.
Herbert St.,	Park St. to West Tremlett St.	Bituminous macadam.

Public Works Department, Sewer and Water Division, Sewer Service. — The following work is in progress:

Kilby St., city proper, Central to Milk sts.; rebuilding old wooden sewer.

Union Park St. Sewage Pumping Station, South End; machinery being installed.

Orleans St. at Marion St., East Boston. Tunneling under B. & A. R. R. freight tracks for 24-in. cast-iron pipe sewer.

At Beach St. outlet near Sullivan Sq., Charlestown; cofferdam for 5 ft. 3 in. circular concrete outlet sewer.

Dorchester Brook sewer rebuilding now near Judson St., Dorchester; large concrete surface drain and 15-in. pipe sanitary sewer.

Davenport Brook conduit, 11 ft. 0 in. x 5 ft. 6 in. concrete. Now at Adams St., near Minot St.; underpinning old culvert and buildings.

The Fore River Shipbuilding Co., Quincy, Mass., has the following work in progress:

U. S. Battleship *Nevada*.

Nineteen U. S. submarine boats.

U. S. Torpedo Boat Destroyers *Cushing*, *Tucker* and Nos. *63* and *64*.

Two oil-tank steamers.

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BOSTON SOCIETY OF CIVIL ENGINEERS
FOUNDED 1848

PAPERS AND DISCUSSIONS

THE ELIMINATION OF GRADE CROSSINGS.

By L. Bayles Reilly, Member Boston Society of Civil Engineers.

This paper, which is the result of the writer's brief experience in grade-crossing abolition projects, is given in the hope that it may be of assistance to some of you who may be called upon to investigate or report upon such projects.

The subject is treated under the following headings:

I. Apportionment of Cost.
II. Manner of Obtaining Elimination.
III. Construction.

I. APPORTIONMENT.

Public safety and convenience require, and public sentiment is demanding, the abolition of grade crossings. Legislatures all over the country are passing laws relative to this matter, and already nearly half of the states have laws touching on the separation of grades.

Two very important provisions of these laws are, first, the fixing of the manner of determining the necessity for proposed work, and, second, the apportionment of the cost. The state of Massachusetts seems to have adopted an equitable and feasible method for determining the necessity of abolition, which will be

Note. This paper will not be presented at a meeting of the Society, but discussion is invited, to be received by Edward C. Sherman, Editor, 6 Beacon Street, Boston, before August 15, 1915, for publication in a subsequent number of the Journal.

described. As far as the apportionment of the cost is concerned, we do not seem to have been quite so successful, since there are arbitrary limits set which may not be equitable when the maximum amount is assessed upon any party, and since commissions have a tendency to assess upon the parties to the work the maximum percentages set by law, irrespective of the actual merits of each individual case.

One has but to note the difference between a crossing on a main state highway in an unpopulated district and a crossing in the heart of the business section of a city like Lynn or Lowell to appreciate that flexibility in the apportionment of cost is desirable. This flexibility is lacking in Massachusetts and in some other states.

In 1912 and 1913 the Massachusetts Railroad Commission and the Massachusetts Highway Commission investigated this subject very thoroughly. In a report to the legislature, an abstract of the laws of each state having any laws on the subject was made, with a review on the advisability of changing the present basis of the apportionment of cost. It was recommended "that the law be amended so as to provide expressly that the amounts assessed upon the cities and towns shall be proportionate to the benefits received, and to the ability of these municipalities to pay; and that the Railroad Commission shall be given the right before the final decree is entered by the court to review the apportionment of the cost as well as the general plan of grade separation made by the special grade crossing commission." No action was taken upon this report by the legislature in the session of 1913, it being postponed to this year's session.

The following is an abstract from the "Report on an Investigation of the Gradual Abolition of Grade Crossings," January 31, 1889, by A. W. Locke, William C. Webber and G. A. Kimball, commissioners, relative to this matter of apportionment:

"Finally, we think that the expense of abolishing crossings should be generally divided between the railroad and the city or town, bringing in the county in special cases, and also the street railways and the adjoining estates, if they are benefited.

"But we do not consider it practicable for the legislature to fix in advance the proportion to be paid by parties interested, for the reason that in no

two places that have so far come under our observation have the benefits or the disadvantages been equally divided. We would recommend that each one be divided on its own merits by some tribunal such as we have hereinbefore suggested."

Hence it is seen that the two commissions which have investigated this subject thoroughly have recommended an apportionment based upon "merit" and "special benefit."

From the abstract of laws compiled by the Railroad Commission it is seen that in Arizona, California, Michigan, North Carolina and Wisconsin full power is delegated to the commission to apportion the cost according to the equities in each particular case, *recognizing* the principle of "Special Benefit."

In Connecticut, Massachusetts, New Hampshire, New Jersey, New York, Ohio, Vermont and Washington the legislatures deny the commissions this privilege, and fix definite limits to the proportions to be paid by the various parties. These limits are arbitrary and cannot be changed even though the conditions of a particular case warrant a different apportionment.

In New Hampshire and New Jersey the entire cost is imposed upon the railroads under all conditions.

In Connecticut, New York and Washington the principle of priority in location is recognized.

In Connecticut the entire cost is paid by the railroad when the petition to separate grades is made by the railroad. In case the petition is made by the municipality, it may be charged 25 per cent. at highways in existence before the railroad was built, and 50 per cent. at crossings built across a railroad location.

In New York, when a new railroad is constructed across an existing highway above or below grade, the entire expense is borne by the railroad; whenever a new street is constructed across an existing railroad, the railroad company and the municipality divide the expense equally; and whenever a change is made in an existing crossing, the railroad pays 50 per cent., the municipality 25 per cent. and the state 25 per cent.

In Washington the railroad pays the entire cost when it crosses over or under an existing highway, and in all other cases

it bears a portion of the cost, depending upon the equities of the case.

In Massachusetts the railroad pays 65 per cent. of the cost on the assumption that it receives the most benefit from the abolition. The street railway, when there is one, pays a maximum of 15 per cent.; and the remainder of the cost is apportioned between the commonwealth and the city or town, but not more than 10 per cent. of the total cost may be apportioned on the city or town.

The cost has usually been apportioned as follows: Railroad, 65 per cent.; commonwealth, 25 per cent.; and the city, 10 per cent. Where a street railway is involved, the steam road usually pays 65 per cent., the street railway 15 per cent., the commonwealth 10 per cent., and the town 10 per cent., although in the last two apportionments of note, at Quincy (estimated cost, \$250 000) and at Taunton (estimated cost, \$2 800 000), the street railway was assessed 12 per cent.

The following are statistics obtained from the Railroad Commission's Report of 1913 to the legislature, and from Mr. H. W. Hayes, engineer of the Public Service Commission:

COST OF THE ELIMINATION OF GRADE CROSSINGS, ACTS OF 1890, TO NOVEMBER 30, 1907.

	Number.	Average Cost.	Total Cost.
Crossings in Boston.........	34	\$340 000	\$11 559 352
Crossings outside of Boston..	303	58 164	17 623 839
Total....................	337	86 597	29 183 191

From the report of the Commission of 1888, information from various sources made it apparent that there were at that time 2 267 highways crossing railroads at grade. Returns made to the Board of Railroad Commissioners as of June 30, 1912, showed that there remained in the commonwealth 1 784 crossings at grade, making a total of 483 crossings abolished from 1889 to 1912.

The total amount expended on the elimination of grade crossings to January, 1913, is \$39 144 286, or an average of \$81 000 per crossing. I have it upon competent authority that the average yearly maintenance of crossings is \$1 200 per year,

including wages of crossing tenders, maintenance of crossing gates, planking, etc. Capitalizing this at 5 per cent. indicates that the railroads could afford to pay $24 000 per crossing, or 33.7 per cent. of the average cost of $81 000, without considering the benefits to be received from increased speed, facility of operation and the elimination of accident claims.

This is apparently the only determinant factor in the whole problem of apportionment; the others must be approximated from traffic counts and other data obtainable in individual cases. It is quite generally conceded that municipalities receive more than a 10 per cent. benefit from abolitions, but that this low figure was arrived at to encourage petitions for eliminations. There can be no question as to the success of this idea, as there are now pending proceedings for about one hundred grade-crossing abolitions.

II. MANNER OF OBTAINING ABOLITION OF GRADE CROSSINGS.

When a town, city, railroad or street railway wants a grade crossing abolished in Massachusetts, a petition is submitted to the Superior Court, which thereupon appoints a special commission of three members. This special commission, after holding a hearing, decides upon a plan, apportions the cost, specifies what part of an existing public or private way shall be discontinued, the grade for the railroad, the way the changes are to be made in the location and grades of the street railway, the general method of construction and what land and other property it considers necessary to be taken. It also prescribes the manner and limits of the work and determines which of the interested parties shall do the work. Land owners, railroad, commonwealth, city or town and street railway present their suggestions and criticisms of proposed plans, and in this way the best plan is evolved.

In some instances where there is a direct conflict of opinion as to the manner of abolition, the matter is carried to the state legislature, which passes an act on petition authorizing the abolition and specifying in detail the method to be adopted and the apportionment of the cost. An act of the legislature is

necessary when work is contemplated in conjunction with grade-crossing work, which could not be actually considered as part of it, as when the railroad wishes for an extension and amplification of its facilities. An instance of this is found at Lynn, where the Boston & Maine Railroad is improving its tracking facilities by the abolition of grade crossings and by increasing the number of main line tracks from two to four.

There are two other methods of obtaining the abolition of crossings:

I. By the agreement of the interested parties, the Massachusetts Public Service Commission can be made the special commission with the same powers and duties as above described.

II. If the directors of the railroad and the selectmen of a town agree upon a plan for the abolition of a crossing, and if this agreement is approved by the Public Service Commission, the crossing may be abolished, provided the railroad and the town together pay 80 per cent. of the cost. The commonwealth pays the remaining 20 per cent. in such cases. Georgetown, Mass., furnished an instance of this procedure in 1913. For details of this method see Chapter 544, Acts of 1910.

III. CONSTRUCTION.

Actual cost is perhaps the most interesting thing to the parties involved, after the apportionment is decided upon. The following are a few unit prices the writer has found useful when estimating the cost of construction of such projects. They are based on labor at $2.00 a day and the prices of materials current in 1912, but do not cover all cases, since accessibility of the work, length of haul, traffic and other factors influence them very much and *each case* must be considered *independently*.

Unit Costs.

Earth embankment (under traffic)	$0.70 cu. yd.
Earth embankment (from trestle)	0.40 cu. yd.
Earth excavation	0.50 cu. yd.
Pile foundations, spruce 25 ft. 0 in. long	5.00 per pile.
Retaining wall (concrete)	7.00 cu. yd.
Abutments (concrete)	7.00 cu. yd.
Macadam roadway	0.80 to 1.25 sq. yd.

Granite block paving (new) gravel joints....	$2.00 to 2.50 sq. yd.
Granite block paving (relaid).............	0.70 sq. yd.
Brick sidewalk..........................	1.10 sq. yd.
Granolithic walks........................	1.80 sq. yd.
Tar concrete walks......................	0.75 sq. yd.
Edgestones reset........................	0.25 lin. ft.
Edgestones new.........................	1.00 lin. ft.
Surface drains..........................	1.80 lin. ft.
Relaying water pipe.....................	3.00 lin. ft.
Arch culvert masonry (small spans).........	12.00 lin. ft.
Temporary platforms (plank)..............	1.20 sq. yd.
Iron fencing............................	1.50 lin. ft.
Wooden fencing.........................	0.50 lin. ft.
Main railroad tracks.....................	1.50 lin. ft.
Temporary railroad tracks................	0.50 lin. ft.
Railroad trestle, temporary................	10.00 to 15.00 lin. ft.
Bridge steel.............................	0.045 per lb. in place.
Timbering, per M. ft. B. M., in place.......	60.00
Drains: 18 in............................	1.50 lin. ft.
12 in..........................	1.00 lin. ft.
8 in...........................	0.80 lin. ft.
Taking up and relaying street railway track, without betterment....................	1.25 per ft.

The work is done by the railroad, and, as might be imagined, the actual cost is sometimes the subject of considerable discussion among the other parties. Charges are kept according to the specifications of the Interstate Commerce Commission, similar to ordinary railroad charges.

After the completion of the work the expense of maintenance and repairs is paid as follows:

Section I, Chapter 156, Acts of 1912, Quotation.

"After the completion of the work, the expense of maintenance and repair shall be paid as follows: If the public way crosses the railroad by an overhead bridge, the framework and flooring of the bridge and its abutments shall be maintained and kept in repair by the railroad corporation, but the approaches of the bridge, and, if said flooring has a wearing surface, consisting of an upper planking, paving or other surface material, such wearing surface of the bridge shall be maintained and kept in repair by the city or town in which they are situated; if the public way passes under the railroad, the bridge and its abutments shall be maintained and kept in repair by the railroad corporation, and the public way and its approaches shall be maintained and kept in repair by the city or town in which they are situated; if the several rail-

roads cross the public way at or near a given point, the commission shall apportion and award in what manner and proportion each of said railroad corporations shall maintain and keep in repair the framework of the bridge and its abutments, if the public way crosses the railroad by an overhead bridge, and the bridge and its abutments, if the public way passes under said railroads."

The Superior Court appoints as auditor, a disinterested person, not an inhabitant of the city or town in which the crossing is situated, who audits all accounts of expense incurred by the railroad, street railway company, city or town and special commission. This auditing, when accepted by the court, is final.

It often happens that in connection with grade abolition projects, improvements in railroad or city facilities are made, such as street widening, increasing the number of railroad tracks, or increase in freight handling accommodations. Such things as these are to be paid for by the one who receives the benefit of the betterment. A sharp distinction is sometimes impossible as to just what is betterment and what is necessitated by the abolition of grade crossing.

The following is given as an instance of how some of the main features of a plan are adopted. The railroad, since it pays the greatest portion of the cost, asks, as a rule, for a 5 per cent. or 6 per cent. street gradient. For traffic reasons the city usually objects to anything over 3 per cent. The result in many cases is a compromise, streets on main thoroughfares being built with not over 3 per cent. grades, other streets not on main thoroughfares with as high as 7 per cent. grades. In one case, in Fall River, 12 per cent. was allowed on account of the fact that this gradient existed on adjacent streets.

The question of land damage enters into this question of street grades, and the two should be considered together. As a general rule, when land damage is high, street grades are heavy, and when land damage is low, street grades are low.

The question as to whether the street is to cross over the railroad or vice-versa is determined by considerations of economy. Where several crossings are to be eliminated which are fairly close together, the railroad can be raised above the streets or depressed below them. As stated before, it is not usually economical to depress the railroad. The important elements which

determine track elevation, or street elevation or depression, are accessibility of dump for excavated material, the number and length of bridges crossing the railroad, the length of haul to borrow pit, drainage of railroad if depressed, the drainage of streets if depressed, and the architectural question of civic beauty. In the case of the elimination of a single crossing, railroad elevation or depression is not economical since the railroad grades are usually limited to .57 per cent., while street grades vary from 2 per cent. to 7 per cent. The result is the elevation or depression of the street. This applies not only to a single isolated crossing, but also to the case where several crossings are so far apart that the cost of railroad elevation or depression is high.

Each particular problem must be studied carefully before any plan is adopted. Estimates of cost should be made, if necessary, to determine which of the following methods should be used: First, railroad elevation; second, railroad depression; third, street elevation; fourth, street depression; or a combination of railroad elevation with street depression or vice-versa. It must always be borne in mind that, if railroad depression is adopted, the track must be lowered about 21 ft., 18 ft. for clearance and 3 for bridge floors, while if track elevation is used, there is a change in grade to be made of about 17 ft., 14 for clearance and 3 for bridge floors. Except in the case of sidetracks, which may be made 16 ft., these clearances are required in Massachusetts, unless authorized otherwise by the Public Service Commission.

In Canada the Railway Act provides that every bridge over a railway shall have a clearance of at least 7 ft. above the top of the highest freight car, such clearance never to be less than 22 ft. 6 in. above the base of rail, except with the approval of the board. An appeal was made from this in 1911 for a clearance of 19 ft. by the roads entering Toronto. The commission ordered the standard clearance of 22 ft. 6 in. to be provided.

Some of the other factors to be observed in the design or the comparison of proposals for the elimination of grade crossings follow:

Land damage on an abolition project is complicated and is left for the legal fraternity and the real estate experts to settle.

The engineer's duty in this matter is to see that excessive damage is avoided by building retaining walls. Where land is cheap, take it; where it is expensive and damage can be avoided by the construction of a retaining wall, investigation and estimates must be made to determine the comparative cost. Common practice has established the following rule in estimating the cost of land damage:

Where a taking is made, the estimate is twice the assessed valuation of the land and buildings. Where there is damage due only to change of street grade, 60 per cent. of the assessed value is figured for the damage. This rule is an arbitrary one which usually works out on the safe side, but in many cases does not.

LAND DAMAGE SETTLEMENTS. PERCENTAGE OF ASSESSED VALUATIONS.

Town or City.	Years.	Number of Cases.	Grade Damage.		Per Cent.	Land Takings.		Per Cent.
			Assessed Val.	Settlement.		Ass'd Val.	Settlement.	
Somerville, Dane St....	1912	19	$46 500	$32 650	70	.....	.....	....
Somerville, Webster Ave........	1910	1	......	......	....	$5 500	$7 500	136
Somerville Webster Ave.......	1910 –12	43	202 500	89 635	44.3	.....	.....	....
Somerville, Medford Ave........	1912	1	2 500	1 400	56.1	.....	.....	....
Lynn...............	1910 –12	37	179 550	53 419	29.7	.....	.....	....
Lynn...............	1910 –12	4	......	......	....	31 400	46 800	149
Neponset............	1910 –12	5	14 789	17 500	118.5	....	. ....	....
Neponset............	1910 –12	11	......	......	....	20 812	31 691	152.5
Total Gr. Dam., 44% of Ass'd Val.........		105	445 839	194 604	....	.....	.....	....
Total Gr. Takings, 145% of Ass'd Val...		16	......	......	....	57 712	85 991	....

The preceding table shows the percentage cost of grade damage to assessed value in 105 actual settlements to average 44 per cent., and the percentage cost of land takings in sixteen actual takings to be 145 per cent.

All Settlements Included.

At the Boston, Revere Beach & Lynn Railroad crossing, at Saratoga Street, East Boston, abolished in 1913, the damages paid amounted to 89 per cent. of the assessed value.

In the abolition of the East Boston grade crossings, seven in all, in 1906, the damages amounted to 32.43 per cent. of the assessed value, omitting two small payments to large estates, the Standard Oil Company and the National Dock & Warehouse Company.

In the abolition of the Dorchester Avenue grade crossing in Boston, 1900, the land damage was 71 per cent. of the assessed value.

From this it is seen that the use of the arbitrary figures of 60 per cent. for land damage and 200 per cent. for land takings must be accompanied with the exercise of some discretion. In using the value of 200 per cent. for land takings, it is customary, where large estates are under consideration, to use a depth of 100 ft. from the line of grade change.

Another method of arriving at a figure for land damage is to obtain an appraisal of the property as it stands from a disinterested expert, show that expert the amount of damage caused by the project, get another appraisal from him, subtract the two appraisals, add to the result 25 per cent., and this result will usually be much closer to the actual cost than the arbitrary allowance of 60 per cent. This method is based on the fact that an abutter is entitled to have his property left in the same condition and relative location, after the grades are changed, as it was before, or, if this is impossible, a sufficient sum of money to cover this change, with the market value of the property as the upper limit of such sum. The choice of methods should be governed by the exigencies of each case.

A feature that is very important is the proper provision for the maintenance of traffic during construction. This is done by

temporary crossings over adjacent land, or, when this is not possible, other methods, such as the construction of one half the structure at a time, are adopted.

The discontinuance of public ways or the continuance of them involving real damage to property without redress at law should not be permitted unless circumstances absolutely compel such discontinuance. The proper drainage of streets should not be interfered with by the depression of them under the railroad, nor should the flow through trunk-line sewers be hindered. Street junctions should be carefully planned to avoid danger points, pockets and sharp grades.

The devotion of taxable property to new streets and ways should not be allowed unless the benefit received is greater than the loss incurred. This is a point which often causes a loss to cities and towns which cannot be retrieved.

Traffic routes should be made as direct as possible, since circuitous routes are apt to cause the introduction of danger points at street junctions and to inconvenience pedestrians greatly. Railroad stations should be easily accessible to traffic, vehicular, street railway and foot, in grades, elevations and layout. Station driveways and automobile and carriage yards should be built wide, and with an eye to increasing traffic volume.

Provision should be made for future industrial side tracks, as lack of foresight in this direction is apt to cause inconvenience and expense and actually hinder the future commercial development of the community.

Structures.

On main city thoroughfares, depressed under the railroad, solid, ballasted bridge floors are to be commended. They should be well waterproofed with pitch and tarred felt, to render them drip-proof. The depth of floor is fixed by grade and clearance requirements. Where more than three tracks pass over the street, the bridge should be divided into two parts, to prevent darkening of the street, although the railroads usually object to this, since it introduces curves in the track. The usual construction over streets consists of through steel plate-girder spans. Where streets and sidewalks are wide enough, the cost of these structures

may be reduced materially by providing supporting bents on the curb lines or at the center of the street, although many cities prohibit the use of these bents for traffic reasons. In outlying sections open floor bridges are used to a large extent. It must always be remembered, however, that these grade-crossing abolitions are permanent, and the structures provided should be made as permanent as circumstances warrant. The use of concrete slab floors with ballast well waterproofed is likely to be the most economical in the long run, since maintenance charges are reduced, constant inspection is not necessary, and nuisances from noise and water-dripping obviated.

Highway bridges over railroads should be designed to accommodate the loads passing over them, and when carrying street railways, should be designed according to the "Specifications of the Massachusetts Railroad Commission for bridges carrying street railways, 1908." In general, the practice obtaining in the cities or towns in which they are located should be followed.

Apportionment of Work.

It is customary in Massachusetts for the special commissions to apportion the work to be done. They usually prescribe that the work is to be done by the railroads, other public service companies doing the work involving changes in their respective lines. It is seldom provided that municipalities do the work involved in the street changes, such as paving, street surfacing and edge-stone setting. This frequently leads to trouble, as the railroads naturally want the work done as cheaply as possible, and sometimes succeed in accomplishing a cheap-looking job as a result. It would appear that, if the towns and municipalities were permitted to do such work as this, which they are probably equipped to do in better and more permanently economical fashion, one incipient cause of disagreement could be eliminated.

Betterment.

It is the duty of the engineers engaged in this work to see that no betterment is made in any work connected with grade

abolition (see decision of Supreme Court of Massachusetts, Reports, Vol. 172, 1898–99, pp. 5–11 inclusive) unless the parties making any betterments pay for them themselves. In the making of plans, criticising of plans, and in the checking of the costs, the question of *Betterment* versus *Reasonable* and *Suitable Substitution* for existing facilities confronts the engineer. A broad and equitable attitude must be taken toward this question for the mutual benefit of all concerned.

The following is a recapitulation of the points to be observed in designing or criticising the design of a grade abolition project:

1. Cost.

2. Discontinuance of important public ways or continuance of same involving real damage to property without redress at law.

3. Drainage (railroad and highway).

4. Sewage flow (pipe changes, etc.).

5. Street junction, avoidance of danger points and pockets.

6. Minimum of taxable property to be devoted to new streets and ways.

7. Traffic routes — vehicular and street railway, distances, grades and maximum avoidance of curves.

8. Railroad grades should be slight at stations.

9. Highway grades.

10. Accessibility of stations to traffic — vehicular, street railway and foot.

   (*a*) In grades, elevations and layout.

   (*b*) Station driveways and carriage yards.

11. Industrial sidetracks.

12. Bridge headroom.

13. Minimum of land damage.

14. Maintenance of traffic during construction.

15. Bridges and other structures — strength, permanence, waterproofing.

16. Apportionment of work.

17. Betterments.

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PAPERS AND DISCUSSIONS

This Society is not responsible for any statement made or opinion expressed in its publications

ADDRESS AT THE ANNUAL MEETING, MARCH 17, 1915.

THE DUTIES AND SPHERE OF ACTION OF A LOCAL ENGINEERING SOCIETY WITH SPECIAL REFERENCE TO THE BOSTON SOCIETY OF CIVIL ENGINEERS.

By Harrison P. Eddy, President, Boston Society of Civil Engineers.

The past year has been an important one in the history of our Society, which is now completing its sixty-seventh year. The interest of our members in the affairs of the Society attests their appreciation of the opportunities it offers and the obligations it imposes. The first volume of the Journal of the Boston Society of Civil Engineers has been completed. It is a credit to the Society, to the contributors, and to the editor, to whom the Society is indebted for the skillful and painstaking work which has resulted in the publication of this very attractive volume.

A year ago our membership was 837. To-day the members and applications on file number 1 004, an addition of 167 in spite of general business depression and the fact that many engineers have been out of employment and many others have felt it wise to husband their resources much more scrupulously than usual. There must be a cause of fundamental importance behind such growth, for even in view of the efforts of the membership committee, which has worked hard and conscientiously, so great a growth in such an unfavorable year is remarkable.

The cause must be the belief that the Society can furnish what engineers want and need, and we may well pause at this time and ask ourselves what has the future in store for us and what are our obligations.

The Constitution states:

"The objects of this Society are: the professional improvement of its members, the encouragement of social intercourse among engineers and men of practical science, and the advancement of engineering." (Art. I.)

It is important to keep these objects clearly in mind, but a study of the foregoing quotation leads to the conclusion that while the objects are specific they are of such a nature that there may be wide latitude in the selection of the activities of the Society. A comparison with the objects of the American Society of Civil Engineers* shows that the objects of the two societies are similar, although that of the national organization lays emphasis upon the "maintenance of a high professional standard" while that of the local society makes prominent "the encouragement of social intercourse among engineers and men of practical science. . . ." So far as the wording of the respective constitutions is concerned, the difference is slight, but as a matter of practical application it is an important one.

Encouragement of Social Intercourse.

The membership of the national society (about 7 500) is not only very large but is widely scattered throughout the country, and in fact throughout the countries of the world. It is not possible for the general membership to engage in social intercourse. The average member cannot expect to have the benefit of personal acquaintance with more than a small fraction of the members; if located in one of the larger American cities this number will probably not exceed 100 or 200, and if

* "Its object shall be the advancement of engineering knowledge and practice and the maintenance of a high professional standard among its members." (Constitution, A. S. C. E., Art. I, Sect. 3.)

The Constitution of the A. S. C. E., Art. I, Sect. 4, stipulates that "among the means to be employed for this purpose shall be: meetings for the presentation and discussion of appropriate papers and for social and professional intercourse; the publication of such papers and discussions as may be deemed expedient; the maintenance of a library, the collection of maps, drawings and models, and the establishment of facilities for their use." (Constitution, A. S. C. E., Art. I, Sect. 4.)

located in a small municipality at considerable distance from a large city, he is fortunate indeed if he has an acquaintance with more than fifty members, — say 2 per cent. and 0.7 per cent. of the members, respectively.

In a local society, on the other hand, there is a much greater opportunity for social intercourse. But in spite of this fact, the average member of the Boston Society of Civil Engineers probably is acquainted with less than one hundred members, and there are few whose acquaintances include as many as 250, — 10 and 25 per cent. of the members respectively. Does not this indicate a serious failure to fulfill properly one of the objects of the Society?

Several functions have been held in recent years to develop the social life of our Society, among which may be mentioned the annual dinner and smoker, the dinners of the Sanitary Section, the dinner of the joint engineering societies, students' night, ladies' night, and, finally, the dinners of the past year preceding some of the regular meetings. Notwithstanding these opportunities for social intercourse there is still something lacking. Every resident member should know at least a majority of the resident members, and he should know them well enough to enable him when meeting them to select topics of conversation which will be of mutual interest and benefit.

The Board of Government, through appropriate committees, may well encourage social intercourse with particular reference to providing opportunities for the members to increase their acquaintance. But it is not wholly a responsibility of the Board of Government and its committees. Every member should accept his share of the obligations, and if each will exert himself a little the result will be of great benefit to the Society. We admit new members, but do we afford them proper opportunities to become acquainted with their new associates?

I have taken up the social department first because I believe it to be of fundamental importance to the full development of the other objects of a local society. A national society must of necessity confine its activities primarily to the publication of papers, researches by its committees and the development of its library, — all educational functions. This is an

unbounded field of usefulness which has tended toward the "advancement of engineering knowledge and practice and the maintenance of a high professional standard among" the members of the national society. But a local society must do more; it must have a personal interest in and oversight of its members. It should be a sort of fraternal organization, seeking to assist its members in every way consistent with the ideals of the engineering profession and the fundamental principles of professional ethics.

Professional Improvement of Its Members.

The second object of the Boston Society of Civil Engineers is the professional improvement of its members. I class it as second, not because less important than the encouragement of social intercourse, for there are many ways in which it is more important, but because the best progress cannot be made in the professional improvement of the members of a local engineering society until after they have become acquainted, have acquired an interest in the work and activities of their associates, and have established an *esprit de corps* and acquired a loyalty to their society.

The activities of this Society are largely of an educational nature, such as meetings for the presentation and discussion of professional papers, the publication of such papers and discussions, and excursions for the inspection of engineering works.

There seems to be, however, an opportunity to greatly increase its usefulness in this respect. A society should strive to meet the needs of all of its members, and this can be done best by systematic organized effort. There should be papers for the members of each branch of engineering, such as the structural, railroad, bridge, and sanitary engineers. How to accomplish this is not easy to ascertain. There is, at times, much difficulty in securing papers regardless of subjects, and if a committee were confronted with the task of securing papers on specific, predetermined topics, its difficulties would be much increased, but not insurmountable.

Nevertheless, the advantage to be derived is worth the effort. At the beginning of a committee's work it should de-

vote considerable time to a study of the needs of the society and lay out a program for the year's papers which will provide as far as possible for the requirements of all the members. As one of the important functions is to meet and become acquainted with the leaders of the profession, plans should be made to secure addresses from several such engineers each year. It is also the duty of the society to take a live interest in the engineering activities of the community, such as the building of state highways, measures for the protection of the public health, problems relating to the regulation of public service corporations and such more local enterprises as Metropolitan parks, sewers and water works. To this end engineers and officials competent to present these subjects should be given an opportunity to do so, and the members should enter into a thorough discussion of the topics so presented. Such discussions need not be mutual admiration meetings solely, — they should be characterized by an attempt to get at all the truth. All such questions are debatable, and that discussion which brings out different and sometimes opposing views is likely to be most helpful and interesting. Such discussions need not be acrimonious, feelings need not be injured, but a good lively discussion by broadminded engineers would add great interest to our meetings. It may be considered somewhat old-fashioned to suggest holding an occasional debate upon an engineering topic, but it might be an innovation which would prove decidedly interesting.

The society should encourage the presentation of papers by members, each of whom should feel that this is the forum for the discussion of those topics in which he is most interested. To stimulate interest, it may be well to provide one or more prizes or medals similar to that generously donated by our distinguished past president, Desmond FitzGerald. Such a course has been tentatively suggested to the Board of Government by a committee appointed to consider what the Society ought to do for our junior and student members. This committee has wisely recommended devoting more attention to such members, and affording them greater opportunity than they have enjoyed in the past. It is from such members that

the strength of the Society in the future will be derived, and every practicable means of interesting and aiding them should be utilized.

Organization of Sections. — The program suggested, no doubt, seems to many to be formidable and perhaps impracticable. It certainly infers greater activity, more work on the part of officers, and better organization than we have had during the year now closing. But I maintain that it can be achieved without placing an undue burden upon any one. It must be done, however, through more perfect organization, which perhaps may be accomplished most readily by means of additional sections. Our Sanitary Section has been successful from its formation, eleven years ago. The annual average attendance at its meetings has varied from 21 to 88 per cent. of its membership, while that of the Society has varied from 10 to 21 per cent. Its discussions have been good, and there has been a spirit of sociability and good-fellowship which has sprung from general acquaintance and community of interest.

There is an opportunity for several more sections, — for example, a Railroad Section, a Structural Section, and perhaps a Municipal Section. Sections may be formed for temporary work without the intention of their continuing in existence more than a year or two. Certainly no section should be continued if its work is finished or if it neglects to prosecute its work actively. It may be argued that such sections would tend to split up the membership and detract from the interest in the parent Society. This does not seem a necessary or likely result, if reasonable care is exercised in the organization of the sections. It has not proved true of the Sanitary Section.

The sections should be organized to foster interest in special fields, and may act as committees of the Society upon such topics. They should, in fact, be regarded merely as committees. They may be allotted certain stated meetings for which they shall provide and be responsible. Such meetings would perhaps take the place of the special meetings for which there appears to be a demand. Thus organized, the parent Society would hold meetings, at which the tendency would be to present papers which would be attractive and of value to a large proportion

of the members, and to provide addresses of wide interest and speakers of distinction.

Such an organization would increase the capacity of the Society. The work otherwise devolving upon a few officers and committees would be distributed among many. The interest taken in the affairs of the Society would be much increased, for the greater the number of members taking an active part in the proceedings, the greater will be the interest. The members will secure a greater return from their membership, — to put it in a homely way, they will get more for their money and effort.

The Library. — In spite of the effort which has been made to complete files of reports, improve the arrangement and provide a suitable index of our library, there are occasional rumors that it is not all that it should be. As this is one of our most important enterprises, serious consideration should be given to its needs. It is of the utmost importance to determine its proper scope. When considering this we should bear in mind the great wealth of libraries in and around Boston. It may be that the chief feature of this library should be its files of municipal, state, national, foreign and other engineering reports. Such files, to be of value, must be kept up to date, for many reports, while they may be had for the asking when published, cannot be procured a short time after they are issued. The expense of maintaining such files is nominal and they constitute a collection of great value. There should, of course, be a limited supply of journals of engineering societies, engineering periodicals, engineering works of reference, encyclopedias and the like, which will facilitate study at the library, but it is a question how wide a field we should cover and how far we should go. A decided advance would be made if a definite program could be adopted by the Society, and a list of the journals and files of reports ought to be printed either in the JOURNAL or as a part of the year book, that the members may know what journals and reports they may expect to find in the library.

Courses of Instruction. — There is a substantial difference between the requirements of our older and our younger members. The former, having had years of experience, through which

they have attained much of the knowledge which they feel that they require for their regular business, are more inclined to give their time to the addresses of men who have achieved distinction and who can speak of the large problems from personal experience. The younger members, on the other hand, crave definite information and data which they can utilize directly in their work. They feel the need of instruction and are more willing than the older members to give their time to studying the smaller problems with which they come in contact. One way in which we could do more for the younger members would be to provide a few courses of instructive lectures. It might be necessary to compensate such lecturers, and it may be wise for the Society to make a nominal charge for attendance upon such courses, — enough to pay a part or perhaps even the whole of the expense involved. Courses should preferably be limited to four or five lectures and confined to the more common engineering problems.

The Advancement of Engineering.

The third constitutional object is "the advancement of engineering," by which I assume we mean the elevation of engineering as a profession, securing more general recognition of the professional ability of the engineer, and obtaining for him a more generous share of the credit for his work — and, coincident therewith, more nearly adequate compensation for his services. The deficiencies on the part of the public in these respects are undoubtedly largely due to its lack of knowledge, the causes for which have been discussed so often that we may pass over them now. There are, however, certain things which our Society has done for the enlightenment of our fellow-citizens, but a beginning only has been made. It would seem that the time is opportune for a more systematic and a greater effort. Among the efforts thus far made are coöperation of this Society with local organizations of mechanical and electrical engineers, the study of proposed legislation and attendance at committee hearings to advocate or oppose certain bills and the appointment of a representative to prepare for the daily papers reports of addresses and discussions given at the meetings of the Society.

Coöperation of Local Engineering Societies. — It has become the custom for our Society to coöperate with the mechanical and electrical engineers in holding annually a joint dinner and about three other joint meetings. In this way the members of each organization increase the circle of their acquaintance, come to have an interest in some of the problems attracting the attention of the others, and broaden their influence and that of their society.

Such coöperation has social and educational advantages, but of more importance would seem to be the opportunity for advancing the cause of engineering. At such meetings, which are likely to be largely attended, an effort will naturally be made to secure addresses of more general interest than many of those of perhaps a more highly technical nature presented at regular society meetings. A well-directed effort to secure the attendance at such meetings of those who may be interested in the subjects but who are not engineers will aid in placing the work of the engineer before the public in a proper light. Too little has been done in this direction at these meetings and also at regular meetings of our Society. This is a line of work which can be easily taken up and carried along if a little systematic effort can be devoted to it. The expense of printing a few additional notices and of postage will be insignificant, and it would seem that the results to be obtained may be of considerable importance. If such notices could be accompanied by personal letters from members of the societies to acquaintances, inviting them to be present, they would be still more effective.

Interest in Legislation. — It is the duty — too often neglected — of every citizen to take an active interest in matters receiving legislative consideration. Most such measures are of local interest, and therefore are more properly considered by a local than by a national engineering society.

The remark was made, during the past year, that the engineers seem to be almost the only body of men making a pretense at having representative organizations who do not have a committee or especially appointed members to ascertain and report to their society proposed legislation of direct interest

to it. It certainly is an interesting and, I fear, a significant fact that this Society, numbering nearly one thousand members, has not ordinarily seriously considered pending legislation, not taken a part in the movements for or against bills which might have directly or indirectly an important effect upon the engineering profession or upon engineering problems. This year several members of the legislature are engineers, one of whom is a member of our Society. The Board of Government has assumed the responsibility for the appointment of a committee to consider proposed legislation, and take such action regarding it as is deemed necessary. The Board has also authorized and requested members of the Society to attend committee hearings on two occasions and oppose proposed bills which were deemed unwise, in the interest of the public, as well as in the interest of the engineering profession. A committee should be regularly appointed each year, preferably in such a manner that some of its members may hold office more than a single year, thus giving the committee a continuity of personnel which will make it more useful. In this connection I would suggest that the Society may well consider the advisability of simplifying the procedure required by the constitution for the endorsement of measures and provide for authoritative opposition to unwise bills. Such action to be effective must be prompt.

Such a committee may also suggest to the proper authorities the propriety of the appointment of engineers as members of commissions and boards. I do not mean that we should embark upon the treacherous sea of politics, but that we will do well to be informed regarding possible action, and in a dignified, respectful manner make certain that consideration is given to the engineering profession. During the past year the Board of Government authorized a communication to his Excellency the Governor regarding the desirability of the appointment of an engineer to the Advisory Council of the State Department of Health. The Governor extended the courtesy of an invitation to the president and secretary of the Society to a conference at which this matter was discussed, and the Governor displayed an interest in the appointment of an engineer as a member of this Board. Later, such an appointment was

made. While the action of the Board of Government upon this matter may have had no direct effect, the fact remains that an engineer was appointed and recognition thus accorded the profession.

Publicity. — For a brief period during the past year, the Society had a regularly appointed publicity agent, Mr. Roland B. Pendergast. Unfortunately for the Society, but we hope fortunately for Mr. Pendergast, he was appointed secretary to one of the government officials in the Philippines, and was therefore obliged to sever his connection with the Society.

The efforts of Mr. Pendergast resulted in our having about five columns of descriptive matter in the local press regarding the address of Henry M. Waite, City Manager of Dayton, Ohio, presented to the Society November 18, 1914. While this was a particularly favorable subject for newspaper articles, there seems to be no doubt that a properly directed effort might result in a large measure of publicity on many occasions. In this connection, a word of caution may not be out of place, for it is of the utmost importance that care be exercised in the selection of a publicity representative and in the supervision of the work, for all articles appearing in print should be dignified and truthfully representative of the transactions of the Society. The subjects must be so selected and presented as to interest the public, since the newspapers will not accept material which is not of marked public interest.

Probably no field of effort, however, will yield a larger return in bringing the work of the engineer to the attention of the public and in securing from the public a proper recognition of its merits than well-prepared newspaper notices. It therefore seems desirable that a committee should be appointed to attend to this sort of publicity. It is difficult to foresee what expense will be involved in such a movement. There are some who feel that a society of so large a membership should have members who, without compensation, are willing to devote time and labor to reporting its meetings and transmitting proper notices to the newspapers. On the other hand, considerable work is involved, and it must be done at hours which make it more or less laborious. It is not improbable, therefore, that

if the Society should undertake an active campaign of this kind, it will be obliged to finance the effort to a moderate extent. The Society was particularly fortunate in receiving the services of Mr. Pendergast without compensation.

Resources. — Having considered some of the obligations of the Society and suggestions for increasing its activities, it is important to give attention to its resources, for no movement, however meritorious, can be started and carried to successful completion if it involves effort and financial backing in excess of the capabilities of the Society.

The completion of the first volume of the JOURNAL has demonstrated the ability of the Society to successfully maintain this enterprise, which is one of the most important it has ever undertaken; and we may go even so far as to assume that there need be no further anxiety regarding the ability of the Society to finance this project.

Most of the suggestions which I have made require for their consummation only the personal effort of our members. It must be recognized that there is a limit to the amount of time engineers can devote to such work. However, relatively few of our members take a part in the management of the Society or in the preparation of papers and discussions for it. Probably not more than 10 per cent. serve in any office, upon any committee, present papers or take part in discussions during any year. This leaves 90 per cent., or some 900 members, who can be called upon for assistance. Furthermore, it will be found that many of the members who so serve the Society do so year after year. This is a fact to be seriously considered by a society having within its membership efficiency engineers. Our organization can hardly be classed as reasonably efficient when only 10 per cent. of its members are producers. It does not appear extravagant to predict that its efficiency can be raised to 25 per cent. and even 50 per cent., if need be, to accomplish what is clearly desirable. Such an increase in efficiency would not only be beneficial in making possible the few things suggested, but the reflex influence upon those members who would become producers would be so great that the Society would witness a revival of interest and enthusiasm which would

make its work stand out before the public in such a manner that it would compel recognition.

Another of our resources is the great number of engineers in this vicinity who are amply qualified for membership. We must recognize the present unfavorable conditions, but in ordinary times, if we fulfill our obligations to all of our members and take the "place in the sun" to which we are entitled, there is no reason why we should not greatly increase our membership. In this way we can increase the number of producers and also our income.

The increase in members this year, including applicants elected and applications on file, has amounted to nearly 20 per cent. There should result a corresponding increase in receipts from dues which will enable us to finance greater things in the future. But greater activity calls for greater expenditures. The campaign for more members has cost considerable for printing and postage, and this, with our social activities and a determined effort to improve our library by completing files, binding and indexing, have made it advisable to temporarily employ a stenographer to relieve the assistant librarian of some of her clerical duties. It is safe to predict that in the future there will be no great surplus, and it may be necessary to call upon the Permanent Fund for assistance in financing worthy objects.

Permanent Fund. — Article 9 of the By-Laws provides:

"9. *Permanent Fund.* — There shall be a fund called the Permanent Fund, to which shall be added all money received for entrance fees and all income from investments of the fund. No money shall be appropriated from the fund except by a two-thirds vote at two successive regular meetings. Any such appropriation or any part thereof not used within three years shall be returned to the fund."

This fund now amounts to approximately \$35 000. The curve of its increase during the last fifteen years approximates a straight line which if extended would pass the \$50 000 point at about 1922, or in seven years. Our present fund of \$35 000, increased alone by interest compounded annually at 5 per cent., and assuming no losses, will amount to \$57 000 in 1925 and \$72 800 in 1930. As most of our interest is compounded semi-

annually, and the remainder quarterly, the fund will probably grow even faster than these figures indicate if an average rate of 5 per cent. can be maintained. Our By-Laws provide that entrance fees also shall be added to this fund.

This is and will continue to be a goodly fund for such a Society, and should be carefully guarded against inroads for trivial, indefinite or immaturely considered purposes.

There is no constitutional provision specifying the object for which the Permanent Fund is being accumulated. Some have felt that the time will come when the Society will desire a home of its own, and that this fund will aid in procuring it. There are others who think this is unlikely, and that it will always be better to lease quarters than to attempt to own them. Some feel strongly that a portion of the income may be expended with propriety from time to time as worthy objects present themselves, and that the Society should not lay by annually all of its receipts from entrance fees with no definite purpose in view.

Such a fund is of great value to the Society. It gives it an importance in the community which it would not otherwise have. The members feel a sense of responsibility on account of it. Its effect upon the Society is much the same as that of a bank account upon an individual. All members should take pride in it and experience pleasure at seeing it grow.

Nevertheless, we may well consider if, after all, it would not be well to utilize a part of our income as we go along. An individual may be able to exist upon a small part of his income and invest the remainder. But such a course may not always be best for him. He may even increase his income by the judicious expenditure of a portion of the surplus above the amount required for his absolute necessities. It may be so with this Society.

Conclusion.

A survey of the present condition of the Society and a study of its capabilities demonstrates that we can make it just as valuable as we wish, to its members, to the profession and to the public. The chief requirements of the members are

interest, enthusiasm, initiative and a willingness to work for it. The financial problems will take care of themselves. If we will devote an amount of time very small in proportion to that which we spend in establishing and maintaining efficiency for our employers and clients, to promoting efficiency in this organization, the results will far surpass our fondest ambitions.

Vol. II APRIL, 1915 No. 4

BOSTON SOCIETY OF CIVIL ENGINEERS
FOUNDED 1848

PAPERS AND DISCUSSIONS

ADDRESS AT THE ANNUAL MEETING OF THE SANITARY SECTION, MARCH 3, 1915.

THE CIVIL ENGINEER'S CAPACITY FOR LEADERSHIP.

BY BERTRAM BREWER, CHAIRMAN.

THERE is no greater service that one can do for himself or his fellows than to try to enlarge the view by bringing to it a bigger or better conception of one's calling. It is well for us that the officers of engineering societies have over and over again applauded the work of the engineer and proclaimed his large place in this busy world. The sanitary engineer has already attained a wide influence in national and municipal life. When men take things too much into their own hands, in their mad, unthinking race for possessions, the sanitarian is one of the privileged few who can come on to the scene with a "Thou shalt not" in his possession.

The work of this Section has made itself felt over a wide area, and its influence has extended far beyond anything that any feeble words of mine can portray. Yet our dreams are not fulfilled. The cup of opportunity to realize on the vision is still brimming over.

With this high conception of our work and our organization in mind, your retiring chairman would beg the privilege of pointing out the sore need of emphasizing, of encouraging and ennobling the work and the person of the engineer in public

life. There are two or three phases of the municipal problem which might well be emphasized to-night.

First let me call attention to the fact that in all our helping and enthusing we have been unable thus far to reach many of our municipal workers. Very few of these gentlemen belong to this Section, and still fewer attend the meetings. We ought to have them with us here. The year's experience has raised the question, over and over again, — How can we get them in? I would suggest that a committee be appointed to canvass the situation and make recommendations. An interrogatory, wisely and tactfully conducted, might furnish some clews which would be of help. A special evening could be set aside, this coming year, and such a committee be given a free hand in its endeavors to encourage a large attendance of men in the sewer or health service of Metropolitan Boston.

In the second place, your attention is called to a fact seldom realized, that while the first and most important part of the city planning problem is the sanitary one, no one ever hears of sanitary engineers mentioned in connection therewith. A noted landscape architect who sees deeper than many in his profession has this to say on the subject, — "Essential as the elements of sewerage and drainage are to any comprehensive city plan, the planning of them runs on to-day in many places independent of the city plan, and has little influence on the city planning movement." A class of men is being rapidly clothed with authority in Massachusetts cities and towns, called city planners, who utterly ignore the engineer except as a servant to run the transit and rod. For city planning purposes we are supposed not to exist.

Now, gentlemen, we have got to get our minds open to the larger problems as well as the smaller, to the big city itself as well as the infinitesimally small bacterial inhabitant thereof. Our imaginations have not been properly stirred to the point where we understand our prerogative. We, too, should enter the open door. The city planner goes around proclaiming his visions of the New Jerusalem, backed up with innumerable lantern slides of chimerical projects, involving years of efforts and millions of money. He is trained to express his thoughts

in an attractive and inspiring manner, and he is able to point with pride to his noble program and arouse the imagination of his audience to concert pitch, while we, forsooth, spend all of their money and too much of our time in planning and building sewers and filter beds to destroy the deadly pathogenic germ. I venture to say that not until sanitary engineers, and all engineers, get a larger conception of municipal engineering in its relation to the big city plan, and begin to realize that it is the vital part thereof, will good and efficient government come to our cities.

Our conception of our work must also be large enough and strong enough to make us more intelligent about advertising our wares. We too must cultivate some of the accomplishments of our professional brethren. We too must acquire felicity and facility in writing and speaking. Our meetings should be more generally written up for the papers. We ought to appoint a committee on publicity. The public has no adequate conception of what we are doing, and we ought to undertake a scientific method of giving them the information they need.

Let me add a final word, — There's enough clap-trap advertising of cheap wares and nostrums to fill the advertising columns of all the papers on this continent, and enough cheap politicians and fakers to supply the full demand, but until we, who are doing much of the real work of the world, take it upon ourselves to educate and inform the people and stir their imaginations by a concerted and intelligent effort, they will continue to be led far, and far astray about us.

Vol. II MAY, 1915 No. 5

BOSTON SOCIETY OF CIVIL ENGINEERS
FOUNDED 1848

PROCEEDINGS

NOTICE OF REGULAR MEETING.

A REGULAR meeting of the Boston Society of Civil Engineers will be held on

WEDNESDAY, MAY 19, 1915,

at 7.45 o'clock P.M., in CHIPMAN HALL, TREMONT TEMPLE, BOSTON.

Prof. Albert Sauveur of Harvard University will give a talk on "The Structure of Iron and Steel." He will exhibit lantern slides to show how the structure of steel is affected by various treatments and will also call attention to the usefulness of microscopical examination in metallurgy.

S. E. TINKHAM, *Secretary.*

PAPERS IN THIS NUMBER.

"Ground Water Supplies," W. S. Johnson.
(Presented February 17, 1915.)

Discussion of "The Economic Depth of Trickling Filters.

Discussion of "Insurance as an Aid to Engineers."

CURRENT DISCUSSIONS.

Paper.	Author.	Published.	Discussion Closes.
Elimination of Grade Crossings.	L. B. Reilly.	April.	Aug. 15.

Contributors are hereby notified that proof will not be submitted to them for examination unless requested before the 10th of the month preceding the month of publication.

MINUTES OF MEETINGS.

BOSTON, April 21, 1915. — A regular meeting of the Boston Society of Civil Engineers was held this evening at Chipman Hall, Tremont Temple, and was called to order at 8 o'clock by the President, Charles R. Gow. There were 79 members and visitors present.

By vote the reading of the records of the annual meeting of March 17 and the special meeting of March 31 were dispensed with and they were approved as printed in the April JOURNAL.

The Secretary reported for the Board of Government that it had elected the following to membership in the grades named:

Members — Messrs. Raymond W. Coburn, Gregory P. Connolly, Kenneth Tolman Corey, Ralph A. Doane, Arthur L. Gammage, Lucien E. D. Gaudreau, Francis Ingraham Greene, Oliver Perry Sarle, Malcolm Gayton Stocker, Philip W. Taylor, John Franklin Thomas, Edward Broughton Waite and William Austin Wood.

Juniors — Messrs. John E. Allen, Leroy Gile Brackett. Ernest Leon Foley and Reeves Jose Newsom.

The Secretary also announced that the Board of Government, under authority conferred at the annual meeting, had appointed the following special committees for the ensuing year.

On the Library. S. Everett Tinkham, Henry F. Bryant, Frederic I. Winslow.

On Publication. Charles W. Sherman, DeWitt C. Webb, George A. Carpenter.

On Membership. John E. Carty, chairman; Hugh Nawn, George E. Russell, Frank B. Sanborn, Robert Spurr Weston.

On Papers and Program. Lewis E. Moore, chairman; Walter W. Clifford, Samuel L. Conner, Arthur W. Dean, James B. Flaws, J. Arthur Garrod, Joseph H. Libbey, Howard B. Luther, Sturgis H. Thorndike, George C. Whipple, Henry B. Wood.

Social Activities. Edmund M. Blake, chairman; Charles H. Eglee, Frederic C. H. Eichorn, Clarence T. Fernald, Newton L. Hammond, Edwin H. Hayward, Laurence B. Manley, Edwin R. Olin, David S. Reynolds, Charles W. Sherman, Henry A. Symonds.

The Secretary announced the death of two members of the Society, Isaac Rich, who died March 11, 1915, and Benjamin G. Fogg, who died March 14, 1915. By vote the President was requested to appoint committees to prepare memoirs. The committees appointed are as follows: On memoir of Isaac Rich, Messrs. George T. Sampson, Frank B. Rowell and Theodore P. Perkins. On the memoir of Benjamin G. Fogg, Messrs. Leslie H. Allen and J. Arthur Garrod.

Past President Desmond FitzGerald, who had been appointed a committee to prepare a memoir of Robert Leland Read, submitted and read the memoir which he had prepared, and by vote it was accepted.

The President then introduced Mr. J. Albert Holmes, a former member of the Society, who read a paper entitled "Construction of the Earth Dam at Somerset, Vermont." The paper was illustrated by lantern slides. At the conclusion of the reading of the paper, Past President Frederic P. Stearns briefly discussed the paper and added some interesting facts drawn from his connection with the work. After passing a vote of thanks to Mr. Holmes for his kindness in presenting the paper, the Society adjourned.

S. E. Tinkham, *Secretary.*

APPLICATIONS FOR MEMBERSHIP.

[May 7, 1915.]

The By-Laws provide that the Board of Government shall consider applications for membership with reference to the eligibility of each candidate for admission and shall determine the proper grade of membership to which he is entitled.

The Board must depend largely upon the members of the Society for the information which will enable it to arrive at a

just conclusion. Every member is therefore urged to communicate promptly any facts in relation to the personal character or professional reputation and experience of the candidates which will assist the Board in its consideration. Communications relating to applicants are considered by the Board as strictly confidential.

The fact that applicants give the names of certain members as reference does not necessarily mean that such members endorse the candidate.

The Board of Government will not consider applications until the expiration of twenty (20) days from the date given.

COGHLAN, JOHN H., Lexington, Mass. (Age 27, b. Cambridge, Mass.) Graduate of Rindge Manual Training School, 1906; student in railroad engineering course at Boston Y. M. C. A. evening school, 1910. From 1906 to date, with the exception of three months, with the Boston Elevated Railway Co.; is now assistant engineer in M. of W. Dept. Refers to L. S. Cowles, C. T. Fernald, E. R. Kimball, Hugh Nawn, A. L. Plimpton and W. O. Wellington.

DE LA HAYE, ELIAS FRANCIS, JR., Roxbury, Mass. (Age 27, b. St. Owens, Jersey, Eng. Chan. Is.) Student for three years at Rensselaer Polytechnic Inst., civil engineering course. From Aug., 1905, to Jan., 1906, rodman with Smith & Brooks, civil engrs., Lowell, Mass.; from Jan., 1906, to Sept., 1908, rodman, inspector and transitman with N. Y., N. H. & H. R. R.; from Aug., 1911, to Aug., 1913, inspector and transitman with B. & M. R. R.; from Aug., 1913, to Jan., 1915, with C. A. Dodge & Co., Cambridge, as foreman on sewerage system at Billerica car shops and building of new Union Station at Pittsfield; from Jan., 1915, to date, architect on plans for hotel, Boston. Refers to S. P. Coffin, Louville Curtis, L. G. Morphy, F. B. Rowell, A. T. Safford and A. K. Williams.

KATZ, HARRY LEON, Malden, Mass. (Age 22, b. Frankfort-on-the-Main, Germany.) Graduate of Mechanic Arts High School, 1912; is now junior at Tufts College Engineering School. Assistant engineer with T. Stuart & Sons Co. during one summer; detailer with H. Cummings Machine Co. during one summer. Refers to H. P. Burden, S. L. Conner, E. H. Rockwell, F. B. Sanborn and R. C. Smith.

LEONARD, JOSEPH FRANCIS ALOYSIUS, Fall River, Mass. (Age 33, b. Fall River, Mass.) Educated in public and evening schools. From 1899 to 1902, assistant foreman, foreman and superintendent of concrete construction with Beattie & Cornell, general contractors; from 1902 to 1905, rodman and transitman with E. I. Marvell and W. T. Henry, civil and mechanical engineers; during 1906, chief-of-party with E. M. Corbett, civil engineer; during 1907, masonry inspector of reinforced concrete for Southern Railroad;

is now inspector of concrete for Barrows & Breed on Fall River intercepting drain. Refers to V. J. Gallene, E. I. Marvell, H. L. Robinson, G. S. Sawyer and A. L. Shaw.

Parker, Charles Frederick, Woonsocket, R. I. (Age 47, b. Northfield, Vt.) Graduate of Norwich Univ., 1890, civil engineering course. From April to Aug., 1891, with Smith & Brooks, civil engrs., Lowell; from Aug., 1891, to Dec., 1895, with John W. Ellis, Woonsocket, R. I.; during winter of 1895–96, on resurvey of Conn. River division, B. & M. R. R.; from May, 1896, to Feb., 1897, in charge of drafting, masonry, construction and bridges on relocation of B., R. B. & L. R. R.; resident engineer on construction of 48 miles of electric road in southern Massachusetts in spring and summer of 1897; from April, 1898, to Jan., 1899, resident engineer on construction of masonry dam for City of New Britain, Conn.; from March, 1899, to April, 1901, with John W. Ellis & Son; successor to Mr. Ellis, in Woonsocket office, April, 1901, since which time has been in private practice as surveyor and general construction engineer; is one-half owner of Eastern Construction Co., general contractors. Refers to F. A. Caldwell, Willard Kent, F. H. Mills and Arnold Seagrave.

Silverman, Max, Dorchester, Mass. (Age 24, b. Boston, Mass.) Graduate of Mechanic Arts High School, 1909, and of Tufts College, 1914. During year 1910, draftsman for Boston Metal Ceiling Co.; from Sept., 1914, to date, with Boston Transit Commission. Refers to H. P. Burden, S. L. Conner, E. S. Davis, W. W. Davis and F. B. Sanborn.

LIST OF MEMBERS.

ADDITIONS.

Allen, John E. . . . . 11 Dean St., Worcester, Mass.
Corey, Kenneth T. . . . . 102 Stratford Ave., Pittsfield, Mass.
Foley, Ernest L. . . . . 49 Adams Ave., West Newton, Mass.
Gammage, Arthur L. . . . . 151 Hancock St., Everett, Mass.
Gardner, Leroy Ernest . . . . 88 Morris St., Everett, Mass.
Greene, Francis I. . . . . 5 Hoffman Place, Newport, R. I.
Hayes, James, Jr. . . . . 472 Main St., Brockton, Mass.
McNulty, Richard J. . . . . 23 Nottingham St., Dorchester, Mass.
Mills, Hiram F. . . . . 66 Broadway, Lowell, Mass.
Newsom, Reeves J. . . . . 50 Humphrey St., Swampscott, Mass.
Roy, Joseph E. . . . . 11 Dean St., Worcester, Mass.
Weston, Arthur D. . . . . 141 State House, Boston, Mass.
Wood, William A. . . . . 24 West St., Boston, Mass.

CHANGES OF ADDRESS.

Allard, Thomas T. . . . . 834 North 24th St., Philadelphia, Pa.
Bradbury, Royall D. . . . . 68 Devonshire St., Boston, Mass.
Drummond, William W. . . . . Care of Postmaster, Manila, P. I.

Eichorn, Frederic C. H. . . . . 672 Washington St., Brookline, Mass.
Gerrish, Herbert T. . . . . 10 Haskell St., Melrose, Mass.
Gibson, Frederick M. 1932 Beacon St., Boston, Mass.
Lee, Edward G. Room 40, Journal Bldg., Lewiston, Me.
Lewis, George W. . . . . 13 Stockton St., Dorchester, Mass.
Mann, John L. 2500 Municipal Bldg., New York, N. Y.
Morse, Charles F. . . . . 57 S. Clinton St., Poughkeepsie, N. Y.
Parsons, Charles S. . . . . 806 City Hall Annex, Boston, Mass.
Runels, Ralph E. . . . . Box 1417, New York, N. Y.
Smith, Edward R. . . . . 1620 North 61st St., Philadelphia, Pa.
Tosi, Joseph A. . . . . General Delivery, Station A, Worcester, Mass.

DEATHS.

Fogg, Benjamin G. . . . . Died March 14, 1915
French, Alexis H. . . . . Died May 3, 1915
Jenney, Walter. . . . . Died May 3, 1915

EMPLOYMENT BUREAU.

The Board of Government maintains an employment bureau for the Society, to be a medium for securing positions for its members and applicants for membership, and also for furnishing employees to members and others desiring men capable of filling responsible positions.

At the Society room two lists are kept on file, one of *positions available* and the other of *men available*, giving in each case detailed information in relation thereto.

Men Available.

305. Age 22. A student for two years at Dartmouth College and three years at Mass. Inst. of Technology. Has had some experience in surveying at Technology summer camp. Will accept any position along civil or sanitary engineering lines. Salary desired, $60 per month.

306. Age 29. Received technical education at Boston Y. M. C. A. and from American School of Correspondence course. Experience includes six years with Stone & Webster Engrg. Corp'n, and three years with B. & A. R. R.; work has consisted chiefly of detailing and checking structural steel and concrete and general estimating. Desires position along these lines. Salary desired, $25 per week.

307. Age 36. Graduate of Mechanic Arts High School Has had eighteen years' experience in engineering and construction work, including four years as transitman with Street Laying Out Dept., Boston; four years

with U. S. Engineers on fortification work; one year as resident engineer with Mass. Highway Comm.; one year as inspector of concrete on irrigation work in Montana; one year as superintendent of construction with H. Chase & Co., Seattle, Wash., and three years on survey work in Alaska. Desires position as transitman. Salary desired, $85 per month.

308. Age 26. Graduate of Boston College High School; student in electrical engineering course for one and one-half years at Lowell Institute and is now student in civil engineering course with the American School of Correspondence. Has had no experience. Desires position as rodman. Salary desired, $10 or $12 per week.

309. Age 30. Received technical education at Thayer School of Civil Engineering, Dartmouth College. Has had seven and one-half years' experience, including two years of municipal work and about five and one-half years of building construction. Desires position on survey work or inspection of reinforced concrete, etc. Salary desired, $120 per month.

LIBRARY NOTES.

Information Wanted.

We have recently had a call for a pamphlet, written by William Sooy Smith and published in Chicago in 1877, on the Detroit River Tunnel. We have not as yet been able to locate a copy of this pamphlet, and should be glad to hear from any member who can put us on the track of one.

Recent Additions to the Library.

U. S. Government Reports.

Annual Report on Statistics of Railways in United States for 1911-12.

Calcite Marble and Dolomite of Eastern Vermont. T. Nelson Dale.

Composition of Muds from Columbus Marsh, Nevada. W. B. Hicks.

Cretaceous-Eocene Contact in Atlantic and Gulf Coastal Plain. Lloyd William Stephenson.

History of Portion of Yampa River, Colorado, and Its Possible Bearing on That of Green River. E. T. Hancock.

Inorganic Constituents of Echinoderms. F. W. Clarke and W. C. Wheeler.

Lavas of Hawaii and Their Relations. Whitman Cross.

Mineral Resources of United States, 1913, 2 vols.: Part I, Metals; Part II, Non-metals.

National Standard Hose Couplings and Fittings for Public Fire Service.

Oil and Gas Development in North-Central Oklahoma. Robert H. Wood.

Stratigraphy of Montana Group. C. F. Bowen.

Seed Production of Western White Pine. Raphael Zon.

Results of Spirit Leveling in Maryland, 1896 to 1911, inclusive. R. B. Marshall.

Results of Spirit Leveling in Michigan, 1911 and 1913. R. B. Marshall.

Statistics of Express Companies in United States for 1912–13.

Statistics of Railways of United States, 1903–13.

Structure of Fort Smith-Poteau Gas Field, Arkansas-Oklahoma. Carl D. Smith.

Tests of Wood Preservatives. Howard F. Weiss and C. H. Teesdale.

Triangulation in Alabama and Mississippi. Walter F. Reynolds.

Water-Supply Papers 278, 312, 338, 340-F, 340-G, 341, 343, 348, 349, 350, 365, 367 and 368.

State Reports.

Connecticut. Annual Report of Public Utilities Commission for 1914.

Connecticut. Report of State Board of Health on Investigation of Pollution of Streams, 1914.

Massachusetts. Annual Report of Directors of Port of Boston for 1914.

Massachusetts. Supplementary Report of Directors of Port of Boston to General Court, March, 1915.

New Hampshire. Annual Registration Report for 1893.

New Hampshire. Annual Reports of Railroad Commissioners for 1909 and 1910.

New Hampshire. Reports of Public Service Commission, 1911–13.

New Hampshire. Annual Reports of State Board of Health for 1899–1900 and for 1903–12.

New Jersey. Annual Reports of Commissioner of Public Roads for 1909–13.

Municipal Reports.

Albany, N. Y. Annual Report of Bureau of Water for 1914.

Boston, Mass. Annual Report of Boston Transit Commission for 1913–14.

Duxbury, Mass. Annual Report of Water Commissioners, Fire and Water District, for 1914–15.

Haverhill, Mass. Annual Report of City Engineer for 1914.

New Bedford, Mass. Annual Report of Engineering Department for 1914.

New York, N. Y. Annual Report of Department of Water Supply, Gas and Electricity for 1913.

New York, N. Y. Street Paving and Maintenance in European Cities. Henry Welles Durham. Gift of author.

Rochester, N. Y. Annual Reports of Department of Engineering for 1910–13.

Taunton, Mass. Annual Report of Water Board for 1914.

Wellesley, Mass. Annual Reports of Water and Municipal Light Commissioners for 1914.

Worcester, Mass. Annual Report of Superintendent of Sewers for 1914.

Worcester, Mass. Annual Report of Water Commissioner for 1914.

Miscellaneous.

Canada, Department of Mines: Summary Report of Mines Branch for 1913; Preliminary Report on Mineral Production of Canada for 1914; Bituminous Sands of Northern Alberta, by S. C. Ellis; Non-Metallic Minerals used in Canadian Manufacturing Industries, by Howells Fréchette; Peat, Lignite and Coal, by B. F. Haanel.

Institution of Civil Engineers (London). Minutes of Proceedings, Vol. CXCVIII.

Spray Engineering Co.: Sprays for Cooling Condensing Water; Washing and Cooling Air for Steam Turbine Generators.

Tables Annuelles de Constantes et Données Numériques, 2 vols.: Données Numériques de l'Électricité, Magnétisme et Électrochimie, by P. Dutoit and others; Art de l'Ingénieur et Métallurgie, by S. L. Archbutt and others. Gift of International Commission on Annual Tables of Constants.

Where and Why Public Ownership Has Failed. Yves Guyot.

LIBRARY COMMITTEE.

NEW ENGINEERING WORK.

(Under this head a brief description of new engineering work contemplated or under construction will be presented each month. Engineers and contractors are requested to send descriptions of their work to the Secretary, 715 Tremont Temple, Boston, before 1st of each month.)

United States Government. — NAVY DEPARTMENT. — *Navy Yard, Boston.* — Construction of shipbuilding ways. Erection of shipbuilding cranes.

Commonwealth of Massachusetts.—METROPOLITAN WATER AND SEWERAGE BOARD. — *Water Works.*

Bellevue Reservoir. — Work of painting the new steel tank on Bellevue Hill, West Roxbury, which is cleaned with a sand-blast before painting, is in progress. The tank is 100 ft. in diameter and about 45 ft. in height.

A contract for the construction of a masonry tower around the steel tank has been made with the John Cashman & Sons Co. of Boston, and work under the contract should be in progress at an early date.

Pipe Lines. — Work on the 24-in. cast-iron water main in Adams St., Milton, has been resumed under the contract with J. J. Evans of Lawrence.

A large portion of the 60-in. cast-iron water pipes which are to be used in extending the Weston Aqueduct Supply Mains in Commonwealth Ave., Newton, from Prince St. to the Charles River, has been received at the pipe yard and contracts are being made for laying them.

Sewerage Works. — Work is in progress on the relief outfall sewer at Nut Island and on surveys for the high level sewer to Wellesley. An extension of the outfall sewer at Deer Island is contemplated.

METROPOLITAN PARK COMMISSION. — The following work is in progress:

Charles River Reservation. — Plans and specifications for construction of a three-arch masonry bridge over the Charles River at North Beacon St., Boston and Watertown.

Furnace Brook Parkway. — Construction of parkway extension from Quincy Shore Reservation to Hancock St., Quincy. John Cashman & Sons Co., contractors.

Middlesex Fells Parkway. — Rebuilding the northerly half of Wellington Bridge with reinforced concrete girder construction. Coleman Brothers, contractors.

Mystic Valley Parkway. — Constructing parkway from Cradock Bridge to Mystic Ave. Coleman Brothers, contractors.

General. — General repairs to roads and treatments with bituminous binders.

DIRECTORS OF THE PORT OF BOSTON. — *Bulkheads.* — The wooden bulkheads adjoining the site of the proposed dry dock at the South Boston Flats are practically completed, making a total length of 10 305 lin. ft., of which 7 277.4 lin. ft. is composed of oak piles and sheeting 4 in. thick, and the remainder is of yellow pine piles with sheeting 6 in. thick.

Dredging. — The dredging of the Reserved Channel at South Boston east of the temporary entrance by the suction dredge *Tampa* has continued, making 30 ft. at mean low water in a channel 300 ft. wide. It is about 75 per cent. completed. The dredging of the Reserved Channel in South Boston between L Street Bridge and the temporary entrance is being done by J. P. O'Riorden's dredge *No. 8*, and is about 90 per cent. completed. Dredging is in progress at the site of Commonwealth Pier 1, East Boston, by the Bay State Dredging Company, making 40 ft. at mean low water.

Timber Breakwater. — The work on the timber breakwater east of Commonwealth Pier No. 6 is about 82 per cent. completed.

Boston Transit Commission. — *Dorchester Tunnel.* — The Dorchester Tunnel is completed from its connection with the Beacon Hill Tunnel at Tremont St. to the westerly side of Dewey Sq. Train service was begun between Park St. and the Washington station on April 4, 1915.

Section D includes a station under Dewey Sq. and about 450 ft. of tunnel under Summer St., east of the station. Work is now in progress on both station and tunnel. The Hugh Nawn Contracting Co. is the contractor.

Section E includes two single-track circular tunnels which will extend from near the junction of Summer St. and Dorchester Ave. under the Fort Point Channel and private property to a point near Dorchester Ave. between West First and West Second Sts., South Boston. The tunnels will be driven by means of two shields and with compressed air. The shields are now being erected and equipped in the bottom of the shaft at West First St. They are about 24 ft. 5 ins. in diameter, 12½ ft. long and weigh over 80 tons each, not including the hydraulic jacks. The shields were made under subcontract by the Boston Bridge Works. P. McGovern & Co. are the contractors for the construction of the section.

Section H is located in Dorchester Ave. between Old Colony Ave. and Woodward St., and is about 2 200 ft. long. The structure is to be mainly of reinforced concrete, and consists of a single-span double-track tunnel to be built by the cut-and-cover method. The work also includes a pump well, an emergency exit, and sewer changes. Excavation between Middle and Woodward Sts. is under way. The T. A. Gillespie Co. is the contractor.

Enlargement of Park Street Station. — At the junction of Park and Tremont Sts., just north of the station proper, the triangular core of earth has been removed and the work of placing the new steel columns and roof beams and cutting out some of the old concrete walls and roof is now in progress.

This work is being done partly to increase the clearance between the tracks of the double loop in order to enable large semi-convertible cars to pass around the loop on both tracks at the same time.

East Boston Tunnel Extension. — The tunnel extension has been completed with the exception of the interior finish of terrazzo, white cement plaster, etc., of the two stations respectively located under and near the present Scollay Sq. station and under Bowdoin Sq., and also with the exception of their stairways, entrances and exits. Work on the interior finish and on the stairways is in progress. Lowering the grade of the East Boston Tunnel in Court St. between Washington St. and Cornhill is nearly completed. Near Young's Hotel the invert is being removed and the earth underneath excavated to the new grade.

City of Boston. — PUBLIC WORKS DEPARTMENT, HIGHWAY DIVISION, PAVING SERVICE. — Work is in progress on the following streets :

Sanger Street,	from E. Seventh St. to E. Eighth St.	Bituminous macadam.
Winfield Street,	from E. Seventh St. to E. Eighth St.	Bituminous macadam.
St. Andrew Road,	from Bayswater St. to Washburn Ave.	Bituminous macadam.
Frankfort Street,	from Bennington St. to Neptune Rd.	Bituminous macadam.
Braintree Street,	from Franklin St. to Everett St.	Hassam block.
Albano Street,	from Washington St. to Amherst St.	Bituminous macadam.
Barbara Street,	from S. Huntington Ave. to Centre St.	Bituminous macadam.
Jewett Street,	from Neponset Ave. to Mt. Hope St.	Bituminous macadam.
Philbrick Street,	from Neponset Ave. to Jewett St.	Bituminous macadam.
Rosecliff Street,	from Washington St. to Kittredge St.	Bituminous macadam.
Kittredge Street,	from Rosecliff St. to Metropolitan Ave.	Bituminous macadam.
Spring Street,	from Gardner St. to Webster St.	Bituminous macadam.
Temple Street,	from Spring St. to Ivory St.	Excavating, grading.
Hillcrest Street,	from Elgin St. to Temple St.	Excavating, grading.
Seaver Street,	from Blue Hill Ave. to Walnut Ave.	Excavating, grading.
Deering Road,	from Blue Hill Ave. to Harvard St.	Bituminous macadam.
Intervale Street,	from Columbia Road to Normandy St.	Bituminous macadam.
So. Sydney Street,	from Savin Hill Ave. to Bay St.	Bituminous macadam.
Fabyan Street,	from Blue Hill Ave. to Harvard St.	Asphalt pavement.
Dempster Street,	from Ruggles St. to Halleck St.	Hassam block.
Chestnut Street,	from Brimmer St. to Charles River (Ave.).	Bituminous macadam.
Lockwood Street,	from Metropolitan Ave. to Huntington Ave.	Bituminous macadam.

PUBLIC WORKS DEPARTMENT, SEWER AND WATER DIVISION, SEWER SERVICE. — The following work is in progress:

Dent Street Brook conduit, West Roxbury. — In private land, parallel with Dent St., near Pleasant St.

Faneuil Valley Brook conduit. — Faneuil and Oakland Sts., Brighton.

Orleans Street sewer outlet. — In tunnel under tracks of B. & A. R. R. near Bremen and Marion sts., East Boston.

Dorchester Brook conduit and sanitary sewer. — Work now in Judson St., between West Cottage and Brookford Sts.

Union Park Street Pumping Station, South End. — Completed. Machinery being installed.

Kilby Street, Central and Milk Streets, City Proper. — Old wooden sewers being removed and new ones being built.

The Fore River Shipbuilding Co., Quincy, Mass., has the following work in progress:

U. S. Battleship *Nevada*.

Nine U. S. submarine boats.

U. S. Torpedo Boat Destroyers *Cushing*, *Tucker* and Nos. *63* and *64*.

Two oil-tank steamers.

One molasses tanker.

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BOSTON SOCIETY OF CIVIL ENGINEERS
FOUNDED 1848

PAPERS AND DISCUSSIONS

GROUND WATER SUPPLIES.

By William S. Johnson, Member Boston Society of Civil Engineers.

(Presented February 17, 1915.)

A few years ago the prophecy that the time was coming when no unpurified surface water supplies would be used for drinking purposes sounded very rash, but our education in these matters has been so rapid that now, in this part of the world at least, it is almost an accepted fact that some form of purification should be adopted for even the so-called unpolluted surface supplies.

It is not long since a considerable portion of our population, even in Massachusetts, which has always been in the lead in sanitary matters, was contentedly drinking diluted sewage. Now there are few places, and certainly none in Massachusetts, where water which receives the direct discharge of sewage is used for public purposes without purification. We are, however, still drinking water coming from populated watersheds and receiving indirectly the wastes from the entire population as well as the surface wash from streets and fertilized fields, protected only by the natural purification which takes place before the water reaches the consumer. This natural purification would be a perfectly satisfactory method if it could be controlled so as to make its action certain, but some of our worst

Note. Discussion of this paper is invited, to be received by Edward C. Sherman, Editor, 6 Beacon Street, Boston, before August 15, 1915, for publication in a subsequent number of the Journal.

epidemics, like that at New Haven a few years ago, have been caused by the interruption of the natural purification.

Long storage is the most efficient of the natural methods of purifying surface waters, and this method is being developed by many of our large cities. The purity of the supply of the Metropolitan District is largely dependent on long storage. The difficulty is that we are not always certain that we are obtaining long storage, for there is the possibility of local pollution near the intake. The control of the watersheds and the removal of all population from them is, of course, a great aid in securing safe water, especially if the public is excluded from the immediate vicinity of the sources of supply. To supply the population of Massachusetts, however, would require, with a reasonable development by means of storage, a watershed of about one tenth of the total area of the state, and the condemnation of this area is manifestly out of the question.

The demands of the fastidious public have not stopped at freedom from disease-producing pollution, but there is an increasing demand for clean as well as safe water. The public is no longer satisfied to drink dirty or discolored water, even though free from disease germs. It certainly is not appetizing to think of drinking water in which cattle have waded and fishermen have expectorated, or which has flowed over cultivated fields. Neither is it agreeable to drink a highly colored water which has received its color from the organic matter in swamps, and this is what we have to do in the case of many of our surface supplies.

Storage, with the certainty that all of the water will be held for a sufficient time, is a satisfactory remedy for these conditions, and the one upon which we must depend in many cases for some time to come. The only other feasible remedy is filtration.

By filtration, almost any surface water can be made of satisfactory quality for drinking purposes, but, unfortunately, artificial filtration is expensive, and, unless the processes are constantly under the supervision of a trained attendant, reliable results cannot be obtained. In the smaller places it is practically impossible, on account of the expense, to maintain

a proper filtration plant; or, rather, it appears impossible to the majority of the water takers and taxpayers. Fortunately, however, there is available for most of the smaller places, and even for some of the larger places, a natural filtration, cheap and effective and not dependent on the intelligence or faithfulness of any hired attendant.

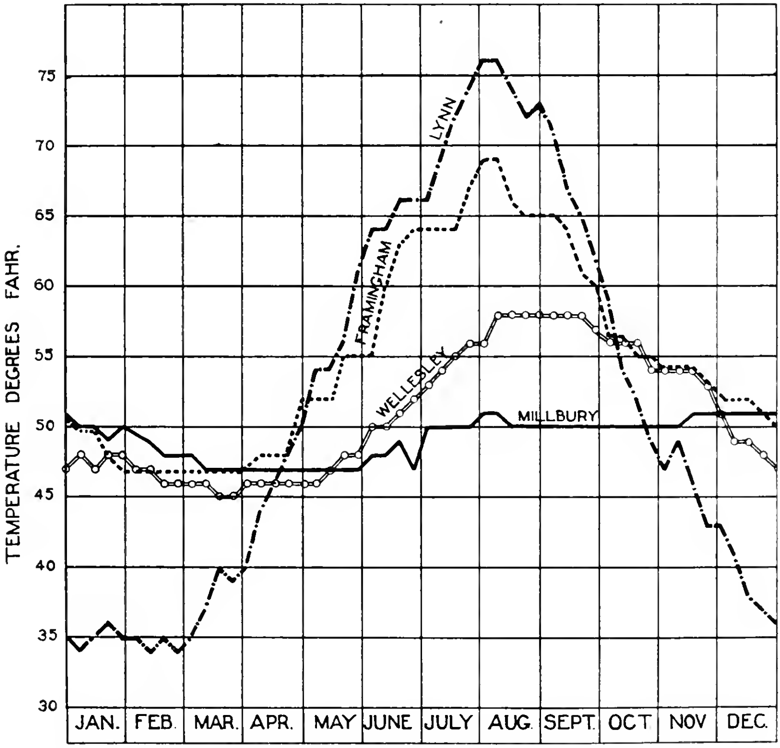

FIG. 1. SEASONAL FLUCTUATIONS IN TEMPERATURE OF GROUND AND SURFACE WATERS.

A considerable portion of the rain which falls upon the surface of the ground enters the soil and flows through it to the most available outlet, which may be a neighboring stream or some distant water course. This water, filtered usually under the most favorable conditions for ideal purification, has all of

the qualities requisite for a perfect water supply, provided certain objectionable qualities which will be referred to later are absent. Good ground waters are practically certain to be at all times cold, colorless, tasteless, odorless and free from dangerous pollution. This is more than can be said of the best surface supply, for such a supply is certain to be warm in summer and to have occasional tastes and odors, and there is always the danger of local pollution.

The temperature of the water is an important factor which is frequently overlooked. Ground waters which are not derived to any considerable extent from a nearby surface source have an almost uniform temperature throughout the year of about 50 degrees. This is sufficiently cold to make the water palatable without ice. Surface waters, on the other hand, reach a temperature of over 70 degrees in summer, although if the water remains long in the pipes it becomes somewhat cooler.

Figure 1 shows the seasonal fluctuations in temperature in typical ground water and surface water supplies. The curve marked "Lynn" is the temperature curve of a pond used for domestic purposes; that marked "Framingham," a filter gallery located close to the shore of a pond and receiving a large proportion of its water by filtration from the pond; "Wellesley," a filter gallery which receives some water by filtration from a river but also a considerable quantity of water from the ground on its way toward the river; "Millbury," a supply which gets little or no water from any adjacent surface source.

The use of ground waters for water-supply purposes is nothing new. They have always been used for domestic purposes, but their general use in connection with public supplies is of comparatively recent origin. At the present time, of the 208 cities and towns in Massachusetts which are supplied with water from public works, about 100 are supplied either wholly or in part from ground water sources. In the main, it is the smaller places which are so supplied; but the city of Lowell, the fourth city in Massachusetts, is supplied entirely from ground water sources, as are the cities of Newton and Waltham, while in other parts of the country very large supplies have been developed. In Germany ground waters are very generally

used, a large proportion of the municipalities being supplied with water derived from such sources.

When ground water supplies first began to come into general use our knowledge in regard to them was very meager. We were dependent upon the expert with the witch-hazel stick or upon the advice of the well driver, and usually the opinion of one was just as good as that of the other. The records of failures of ground water supplies have been numerous, but in Massachusetts they are nearly all those supplies which were installed before the investigations of the State Board of Health were begun. This work, started about twenty-five years ago, has been brought to an exact science under the direction of Mr. X. H. Goodnough, chief engineer of the Board, so that it is possible to predict almost with certainty the quantity and quality of the water which can be obtained from the ground; and the application of this knowledge has prevented many costly mistakes by municipalities introducing water supplies.

It is difficult for the average layman, and even for many engineers, to realize that the laws of nature operate in just the same manner on water beneath the surface of the ground as where the water can be seen. People like to believe that the unseen must be supernatural. This characteristic of human nature has been the chief source of income of many of the well drivers in the past and is the reason why the man with the witch-hazel stick has flourished.

There is another expert, however, who perhaps has done as much harm as the man with the well-driving apparatus or the witch-hazel stick, and this is the theorist who figures out the coefficient of friction in the soil and the velocity and hydraulic gradient of the ground water and determines with nicety just how much water can be obtained from a given source. For such soils as we have in New England, at least, such work is a waste of time and absolutely worthless. The soil varies so in every foot that to obtain results which are accurate to any reasonable degree would require investigation of the soil by means of test wells much more extensive and expensive than would be required to determine first hand, by actual experiment and without any figuring, what the ground will yield.

Ground water is, strictly speaking, any water which is taken from or flows from the ground. It is derived chiefly from that portion of the rainfall which is absorbed by the soil, but also to some extent from the surface water sources, water from which finds its way into the surrounding ground. Ground water sources may be roughly divided into springs, deep wells (sometimes called artesian wells), shallow wells and filter galleries.

With the deep wells we have very little concern. It is sufficient to say that there are very few deep wells in New England which supply a sufficient quantity of good water to be of any assistance in connection with a public water supply system. In Massachusetts, probably hundreds of thousands of dollars have been spent in driving deep wells with a view to securing public water supplies, but there is not one really successful well to show for all of this money.

Springs are ground waters which come naturally to the surface of the ground, and these generally furnish an excellent quality of water. There are few problems connected with the development of such a supply, as the quantity of water which the spring will yield can be seen and measured and there is no reason why its quality should change from time to time. If, however, the spring is developed by putting in a well or wells, the conditions may be very much changed and the supply would then be treated in the same manner as one which is secured from shallow wells.

Shallow wells are those usually not more than 30 or 40 ft. in depth, obtaining most of the supply from rain water which has entered the ground in the immediate vicinity, although they are frequently supplemented by water which is obtained from some nearby stream. To obtain a satisfactory supply from shallow wells it is necessary that there should be an area with pervious soil near the surface which will absorb a considerable portion of the rain which falls upon it, and there should also be a stratum of pervious soil at a reasonable depth which will collect this water. If this deeper pervious stratum can be penetrated by wells, a supply of water will be secured.

Filter galleries or filter basins are those which derive a considerable portion of their supply by filtration from some

adjacent surface source, and they are usually not far beneath the surface of the ground. The proportion of the water obtained from the surface source varies greatly, in some cases being nearly the entire supply. In a few cases the yield of wells or filter basins has been increased by discharging water on the surface of the ground in the vicinity, thus creating what might be termed an artificial ground water. This was done recently in Greenfield, where a well was sunk in a small sandy area near Green River and a dam constructed across the river to divert river water to the sandy land around the well.

The first requirement in seeking a ground water supply is that there should be a watershed of sufficient area to yield the required quantity of water, or that there should be a surface source which can be depended on to supplement the supply. The superficial watershed is not in all cases the watershed which will be tributary to the source after the ground water level is lowered. At Marblehead a well which did not appear from surface indications capable of yielding more than about 200 000 gals. per day has been yielding more than 500 000 gals. per day continuously for many years, and wells far outside of the apparent watershed have been drained.

What the yield of a given watershed will be depends chiefly on the character of the surface soil. There are cases where practically all of the rainfall except that which has evaporated finds its way into the soil, while there are other cases where practically none of the rainfall will enter the ground but will all flow over the surface to the nearest stream. The infiltration from a pond or stream is also exceedingly uncertain. There may be a stratum of impervious material which will almost absolutely prevent the direct infiltration from a surface source, and there are numerous cases where the water is drawn from the ground on the opposite side of a river from the collecting works, the ground water level on both sides of the stream being much lower than the surface of the stream. Another case which frequently arises is that of a deposit of porous material from which water can be drawn freely for a time, but long-continued pumping will exhaust the supply, as the porous material simply forms a reservoir and the flow into the reservoir is small.

Cases have been found where one well yields as much water as many wells driven in the vicinity. Such a case has recently come to my attention in New York, where ten wells were driven, each of which when tested alone gave a good yield. These wells were connected up and a pumping plant installed of sufficient capacity to pump as much water as was expected from the combined wells, but the result was that no more water was obtained from the group of wells than was obtained from the first test well driven.

While experience in these matters will give very much assistance, the only certain way to determine how much water may be obtained continuously at any particular place is by means of tests. The pumping test, as it has been developed by the engineers of the State Board of Health, consists in driving tubular wells and testing each individually until enough good wells are found to yield water at a rate at least as great as will be required for the completed works. These wells are then connected up with a pump, and water is drawn from them continuously for a period, the length of which depends upon the results which are obtained. Observation or witness wells are driven around the area from which the water is being drawn, and a record is kept of the height of water in the ground at frequent intervals. After the pumps are stopped, the observation of the height of water in the wells is continued until the original level is practically reached or the level of the water becomes nearly stationary.

With the results of such a test it is possible, allowing for the difference in yield in a dry season and a wet season, to predict with a considerable degree of certainty the quantity of water which can be obtained from the source.

The necessary duration of a pumping test is generally from one week to two weeks, although there are times when a test of a week is unnecessary and again there are times when a much longer test is desirable. The test usually ceases when the water in the ground reaches a state of equilibrium, or if, after pumping for one or two weeks, the ground water level still continues to go down at a rapid rate.

One of the serious disadvantages in selecting a ground water supply is that expensive tests must be made before it can be

located, whereas with a surface water supply the source can be selected before going to any considerable expense. When a water supply is being considered in a town the money for tests is obtained with difficulty and it is next to impossible to convince a committee that a thousand dollars put into a test will be money well expended, admitting as you must that as a result of the expenditure there may be nothing to show except failure.

TABLE 1.

RESULTS OF ANALYSES OF SAMPLES OF WATER COLLECTED FROM THE WELLS DURING PUMPING TEST AT DUXBURY, MASS.
(PARTS IN 100 000.)

Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Hardness.	Iron.
	Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.		
1914											
June 1	None	Very slight	0	5.00	.0000	.0008	.68	.0300	.0000	0.8	.007
,, 2	None	None	0	4.80	.0000	.0010	.61	.0300	.0000	0.5	.003
,, 3	None	Very slight	0	3.50	.0000	.0010	.58	.0280	.0000	0.5	.007
,, 4	None	None	0	3.90	.0002	.0008	.54	.0220	.0000	0.5	.001
,, 5	None	None	0	3.40	.0006	.0014	.55	.0220	.0000	0.5	.001
,, 6	None	None	0	2.90	.0000	.0006	.59	.0180	.0000	0.5	.001
,, 7	None	None	0	3.30	.0004	.0018	.63	.0180	.0000	0.5	.001
,, 8	None	None	0	3.70	.0004	.0010	.64	.0280	.0000	0.5	.001
,, 9	None	None	0	3.50	.0006	.0016	.66	.0040	.0000	0.2	.000
,, 9	None	None	0	4.20	.0000	.0014	.66	.0200	.0000	0.2	.000
,, 10	None	None	0	2.90	.0002	.0012	.69	.0220	.0000	0.2	.000

The preliminary investigations for a ground water supply cost from five hundred dollars upwards. Many times the first location tested proves satisfactory and the cost is comparatively small. Such was the case recently at Duxbury, where the first wells driven proved absolutely satisfactory. On the other hand, in cases like Bedford and Norton, very extensive tests were required before a suitable supply was secured. The cheapest complete test of which I have any record was at Ashland, where the driving of the wells and the conducting of a pumping test was done for about $225. This was possible, however, only by the use

of a borrowed pump and the services of citizens who volunteered to operate the pump during the test without expense to the town, such was their enthusiasm in getting a water supply. The cost of the test, of course, varies with the size of the plant required, but for a test of from 200 000 to 400 000 gallons per day the wells and the connections will cost in the vicinity of $500, and conducting the pumping test will cost about $30 per day of twenty-four hours, making the total cost of a pumping test of a duration of ten days a little less than $1 000. The wells used in the test can generally be made a part of the permanent works if the test is successful.

The quality of a ground water supply is certain to be good if it does not receive drainage from a considerable population located near the source of supply or if it is not hard and does not contain iron or manganese. These are the only troubles which are at all likely to occur in a ground water supply in this vicinity.

The effect of the population on the territory which feeds the well will not be serious unless the population is large or is located close to the well. The effect of the discharge of sewage into the ground through cesspools will be greater than if the wastes are discharged into vaults or on the surface of the ground, as there is better opportunity for purification when wastes are discharged on the surface. Under favorable conditions the soil will thoroughly purify the wastes from a large population; that is, the organic matter will be changed over to inorganic, and there will be no disease germs in the water. There are, however, certain objectionable qualities in water which has been previously polluted by sewage which should be avoided.

The hardness is of comparatively little consequence in the easterly section of New England, where water is drawn from shallow ground water sources. In deep wells and in certain sections where there is limestone, the hardness may be sufficient to make the water unfit for domestic purposes. The hardness will not change materially with continued pumping and can be determined satisfactorily from a single sample.

The great trouble with ground water supplies is the possibility of the presence of iron or manganese. Without going into a discussion of the chemistry of the subject, it may be said that

iron in ground waters is due to the passage of the water through organic matter which uses up the dissolved oxygen which the water may contain and leaves it with carbonic acid. All sand contains more or less iron, and water containing carbonic acid dissolves the iron from the sand very readily. This, in brief, is the cause of iron in ground waters. As the water subsequently passes through sand which contains free oxygen, the iron will be precipitated and the water will eventually become again practically free from iron.

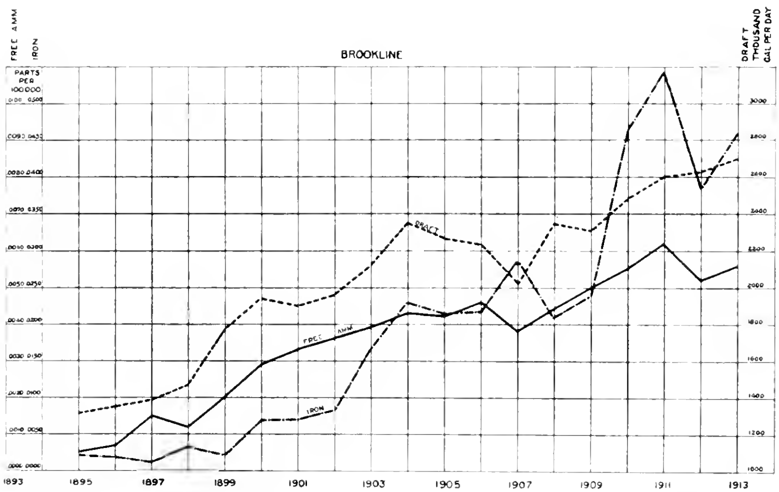

FIG. 2. PROGRESSIVE CHANGES IN QUALITY OF A GROUND WATER.

A source which may furnish excellent water when the draft is small may yield quite different water when a large quantity is drawn from it continuously. This change in the character of the water is due both to the extension of the area from which the water is drawn and to the increased rate at which the water flows to the wells when the ground water level is lowered. The deterioration in the character of the water has been very marked in many of the sources of public supply, especially those which were put in before the modern methods of determining the probable future quality of water were evolved. The deterioration

due to continued pumping is manifest chiefly in the increase in iron or manganese.

The accompanying diagram, Fig. 2, shows the changes in the quality of the water of a typical ground water source which has been in use for a considerable period of years, together with the draft from the source. In some sources which are located near a deposit of organic matter there has been a decided deterioration, while in others the quality has remained good even with a greatly increased draft.

In Middleborough and Lowell the deterioration in the water has been so great that filters have been installed for the purpose of removing the iron, and in Brookline filters will probably be built within a short time.

This deterioration in the water is not universal, for there are a great number of supplies which have continued to give excellent water for a very long time, and this is especially the case where the sources have been selected after a thorough test.

Since the troubles which occur in ground waters are chiefly those which come from the passage of water through organic matter, it is evident that it is desirable to locate the collecting works as far as possible from any such organic deposits. For this reason wells should not be located where they will receive water which passes through deep deposits of peat, and they should not be located close to a stream or pond the bed of which is covered with mud. The distance from such deposits at which it is safe to put the works cannot be foretold, as the purification of the water in passing through the soil depends upon the character of the water, the character of the filtering material and the rapidity with which it passes through this filtering material.

It is found to be generally safe if the well is located at least one hundred feet from the shore of a surface source or from a deposit of peat. Cases have frequently occurred where, by moving the collecting works a distance of a few hundred feet, water of very much better quality has been secured.

One of the most important functions of the pumping test is to determine the probable future quality of the water. It is possible to determine what the quality of the water is in its

natural state as it flows through the ground by means of samples collected from test wells. This is the quality of the water which will be secured if the water should come to the surface of the ground in the form of springs. When, however, the water is pumped from the ground, the conditions are changed very materially. The surface of the ground water is lowered, which tends to draw toward the wells water from a different area from that which would flow to this point naturally. If there is a body of water in the vicinity, the lowering of the ground water level will tend to draw water from this surface source, and the rate of infiltration will increase as the ground water level is lowered, thus producing entirely different conditions from those which naturally exist. This difference in conditions when water is pumped has been responsible for many of the troubles which have occurred with ground water supplies.

While the pumping test is in operation, samples for chemical analysis are collected at least once each twenty-four hours, and so delicate is the test that it is possible to foretell whether there is likely to be trouble with the water in the future. An increase in the iron or in the free ammonia, as the test progresses, is a sure indication of future trouble, although the trouble may not be serious for several years.

In certain soils it is almost impossible to get clear samples when pumping with a hand pump attached to a well, and the turbidity cannot be entirely removed by filtration in the laboratory. Turbid samples generally show iron, and this iron may not be present in the water itself and would disappear as soon as the water came perfectly clear. Cases have been known where this turbidity has remained for several days after water has been drawn continuously from the wells, and the iron content has been high; but eventually water free from iron has been obtained.

As to the relative merits of driven wells, dug wells or filter galleries, there is no question but that the dug well is the most satisfactory, provided the conditions are favorable and if the expense is not too large. Where water is obtained from some neighboring water source and the depth of porous material is small, a filter gallery parallel to the shore of the surface source may be desirable. Where the water-bearing soil is at some

considerable depth it is almost invariably much cheaper to obtain water by means of tubular wells.

Between these two extremes the best method to adopt must be determined by local considerations. One of the advantages of the dug well is that there is a large body of water in store from which to draw while the pumps are being run, and when this is exhausted the well has the time until the pumps are next operated to recover. This means that pumps of larger capacity can be used than with the driven well plant. Furthermore, under these conditions the average suction is likely to be less, as in the case of driven wells the ground water level at the wells goes down quickly when the pumps are started. Perhaps the chief advantage, however, of the large well is the avoidance of troubles from sand and air which are likely to occur in any driven well plant.

Another type of well, used considerably abroad, and to some extent in this country, is a large pipe 6 ins. or 8 ins. in diameter, which is driven into the ground and water is drawn from this well by means of a smaller pipe inserted in the larger one. This avoids the troubles with air and sand to a very large extent, but is, of course, somewhat more expensive

A modification of this type has been used with very good success in two or three installations in this vicinity, by the Hanscom Construction Company. Sections of cement pipe or of tile pipe 2 ft. in diameter are sunk by dredging on the inside of the pipes to the required depth. Water is drawn from these by means of small suction pipes connected up as in the case of tubular wells. These wells are comparatively inexpensive and have proved very successful, avoiding most of the troubles which occur with the ordinary driven well.

The cost of a system for collecting ground water varies greatly with the local conditions. The following tables give statistics in regard to the cost of dug wells and of recent installations of systems of tubular wells.

TABLE 2.

Cost of Dug Wells.

Place.	Year Built.	Depth in Ft.	Diameter in Ft.	Cost.
Bedford	1909	21.0	20.0	$3 981
Avon	1895	22.0	20.0	3 317
Canton	1889	29.0	40.0	8 555
Cohasset	1909	33.67	25.0	3 500
Greenfield	1913	31.0	40.0	7 850
Henniker, N. H.	1914	25.15	20.0	2 141
Manchester	1892	29.0	32.0	10 476
Marblehead	1912	31.0	25.0	6 100
Middleborough		22.0	26.0	4 964
Monson	1895	23.0	72.0	6 803
Needham	1890	24.0	22.0	4 615
Waltham		18.0	40.5	8 940
Ware		23.0	25.5	4 725
Webster		30.0	25.0	13 344
West Warren	1913	18.0	20.0	3 800
Winchendon	1911	35.0	40.0	7 815

TABLE 3.

Cost of Tubular Wells.

Place.	No. and Size.	Depth in Ft.	Cost of Wells.	Cost per Well.	Cost, including Suction to Pumping Station.
Ashland	12 — $2\frac{1}{2}$ in.	25–32	$1 267	$105.50	$1 460
East Brookfield	9 — $2\frac{1}{2}$ in.	20.7 av.	604	67.20	....
East Douglas	9 — $2\frac{1}{2}$ in.	....	....	....	629
Duxbury	22 — $2\frac{1}{2}$ in.	27.8 av.	....	....	3 324
Littleton	10 — $2\frac{1}{2}$ in.	22 av.	....	....	2 000
Merrimac	18 — $2\frac{1}{2}$ in.	35 av.	....	....	3 100
North Chelmsford	20 — $2\frac{1}{2}$ in.	30 av.	2 800	140.00	....
Oxford	15 — $2\frac{1}{2}$ in.	24–28	....	....	800
Pepperell	34 — $2\frac{1}{2}$ in.	19–28	2 704	79.50	3 200
Plainville	11 — $2\frac{1}{2}$ in.	25–50	4 500	....	....
Uxbridge	16 — $2\frac{1}{2}$ in.	26–35	1 800	112.50	....
Wrentham	9 — $2\frac{1}{2}$ in.	29 av.	1 048	116.50	....
Wrentham State School	6 — $2\frac{1}{2}$ in.	....	680	113.20	....
Fairhaven	30 — $2\frac{1}{2}$ in.	$22\frac{1}{2}$ av.	2 040	68.00	5 645
Wareham	12 — $2\frac{1}{2}$ in.	39 av.	1 160	97.00	....

The construction of tubular wells and the method of making connections with the suction pipe are of the greatest importance, as the leakage of a small quantity of air will cause endless trouble; and it is also desirable that it should be possible to cut out any particular well from the system.

The usual size of driven wells in this part of the country is $2\frac{1}{2}$ ins. The adoption of this size is simply the result of experience, as it is found that this is about as large a pipe as can well be driven under ordinary conditions, and it is, of course, desirable to have the pipe as large as is feasible. For the well,

Fig. 3. Driving Pipe by Tripod.

an extra heavy wrought-iron pipe should be used, as in the process of driving the pipe receives very hard treatment and it requires a heavy pipe to stand the strain. The pipes are driven with open ends except in the case of very fine sand, when strainers have to be resorted to. The bottom length of pipe is perforated with a large number of small holes about $\frac{1}{4}$ in. in diameter for a distance of perhaps two feet from the end of the pipe.

The two methods of driving the pipes most commonly in vogue are shown in the accompanying views. The use of the

tripod is simpler, but the platform has the advantage of carrying the weight of the men upon the pipe, which assists materially in sending the pipe down with each blow. It would seem that raising the weight by a rope would be much easier for the men than to stoop down and lift the weight, as is necessary with the

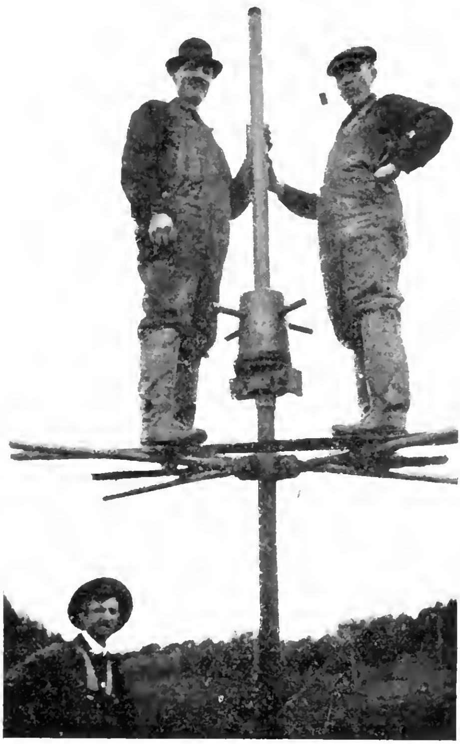

FIG. 4. DRIVING PIPE WITH PLATFORM.

platform. Men, however, seem, if anything, to prefer this method to the tripod method.

After the pipe is driven and washed out, it is cut off at the level at which the suction is to be placed. A long-turn *T* is put on and then the pipe is continued up to somewhat above the

surface of the ground, the object of the extension to the surface being to provide access to the well for cleaning out, as sand is likely to work into the pipe. The well is then connected to the suction with $2\frac{1}{2}$-in. pipe and a lead gooseneck, each connection

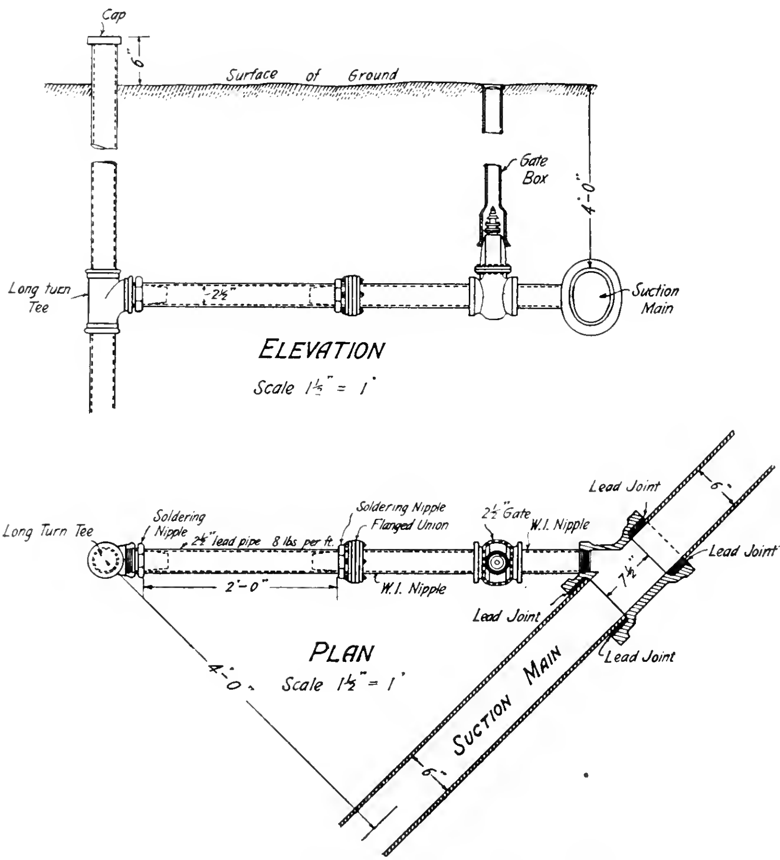

FIG. 5. PIPE CONNECTIONS FOR DRIVEN WELL.

being provided with a gate so that it can be shut off in case it gives trouble. The object of the piece of lead is to give flexibility to the connection and prevent danger of leakage.

There is always a certain amount of sand which finds its way into the water, and to prevent this from getting into the pumps

a sand chamber is put on the suction. This sand chamber is simply a large chamber in which the velocity of the water is sufficiently checked to permit the sand to drop out of the water.

Air is one of the great troubles in a driven well system, and in some cases pumps are installed which operate automatically to remove the air either from the top of the sand chamber or from a special air chamber constructed for the purpose.

Ground water, as has been said, is likely to be of satisfactory quality if it does not contain iron or manganese and if it is not hard. If the water is hard, it is probably not feasible to use it for domestic purposes. If it contains iron or manganese, it is perfectly possible to remove these substances and make the water of satisfactory quality. The filtration of a ground water containing iron is likely to be a much more simple and less expensive process than the filtration of surface waters, although the iron occurs in so many forms or in combination with so many other substances that it is impossible to tell in advance how simple or how difficult the process of removal is likely to be. In the case of Marblehead, for example, the iron is very readily oxidized and precipitated by simple aëration, and then the iron can be readily strained out by passing it through sand filters at a rapid rate. At Reading, on the other hand, the iron occurs in connection with organic matter, which makes it very difficult to remove, and it must be treated chemically. In Germany, where ground water supplies are very largely used, a large majority of them are purified on account of the presence of manganese or iron.

The failure to properly purify a polluted surface water is a serious thing, but the failure of plant filtering a ground water does not mean a possible injury to the users of the water, for the iron or manganese is harmless, and the worst that can happen is to serve water which causes rust spots in the laundry and has an objectionable appearance and taste.

Ground water supplies are usually found in locations where it is necessary to pump the water, and the pumping plant is an essential part of the development of a ground water supply. There are a few cases, like Monson, West Warren and Deerfield, where good ground water supplies are obtained by gravity; but such cases are very rare.

The development of the oil engine in connection with public water supplies is responsible in a very large measure for the increase of ground water supplies in recent years. The cost of construction and operation of a steam pumping plant is so great as to discourage a small town from installing a supply where these are necessary. The oil engine, however, is so much cheaper in first cost, and the cost of maintaining it is so small, that it is more economical to put in a pumping system and pump water from some nearby ground water source than to go to any considerable distance for a gravity supply.

The following facts in regard to the cost of pumping plants may be of interest in this connection.

TABLE 4.

COST OF RECENT INSTALLATIONS OF PUMPING MACHINERY IN SMALL WATER-WORKS SYSTEMS.

Town.	Population (1910).	Cost of Pumping Station.	Cost of Pumping Plant.
Ashland	1 682	$1 935	$4 358
Bedford	1 231	1 857	4 000
Deerfield	......	350	475*
Dracut	3 461	1 730	1 783
Dudley	4 267	1 948	2 500
Duxbury	......	6 181	......
East Brookfield	......	1 628	3 100
East Douglas	2 152	2 500	2 455
Henniker, N. H.	......	1 250	1 757*
Leicester (Cherry Valley and Rochdale)	......	2 368	4 414
Littleton	1 229	3 100†	3 960
North Chelmsford	5 010	2 000	3 500
Pepperell	2 953	2 852	6 200
South Hadley (Fire District No. 2)	......	2 700	6 875
Wareham	......	2 133‡	5 642
West Groton	......	500‡	1 163*
Wrentham	1 743	1 647‡	1 784*

There are in many small towns, ground waters which can be developed to supply a considerable quantity of water which

* Only one unit.
† Includes some grading.
‡ Without pumping machinery foundations.

are so located that the water can be obtained by gravity, although the yield of these sources may be insufficient to supply all the requirements of the town. These ground water supplies may oftentimes be developed economically to supply a portion of the water required, and a small pumping unit can be installed to supplement the supply when necessary. Such installations have been put in recently in the Deerfield Water District and in Henniker, N. H. The gravity supply in these places is sufficient to meet all the requirements during wet seasons, and an inexpensive pumping unit supplies the deficiencies during dry times. The saving to the town in such cases over the cost of installing either a complete gravity supply or a complete pumping supply is very considerable, especially during the first years of the operation of the plant.

Ground water when exposed to light deteriorates very rapidly on account of the growth of microscopical organisms, and, in order to keep a ground water supply satisfactorily, it is necessary to keep it from exposure to the light. Consequently covered reservoirs are absolutely essential. These reservoirs may be either standpipes or masonry structures, the latter being preferable on account of preserving the low temperature of the water.

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BOSTON SOCIETY OF CIVIL ENGINEERS
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PAPERS AND DISCUSSIONS

DISCUSSION OF THE ECONOMIC DEPTH OF TRICKLING FILTERS.

MR. HARRISON P. EDDY * (*by letter*). — Mr. Fuller's discussion clearly sets forth the premises upon which he bases his conclusion "that a trickling filter bed of not less than 6 ft. and not more than 7 ft. will in a great number of cases prove the most economical to use." He agrees that comparable data on the relative efficiency of trickling filters of different depths are very meager, and that there is no accepted method of comparing the purification effected by trickling filters in different localities.

Mr. Fuller states that in the absence of any definitely accepted method of comparing the efficiency of different filters, he has used the formulæ suggested to the Royal Commission by their chemist, Dr. George McGowan, explained at length in the Fifth Report of the Royal Commission, Appendix 4, pages 1–50. By the use of these formulæ Dr. McGowan and Mr. Colin C. Frye reached the following conclusion with respect to percolating filters of coarse or of medium to coarse material from 6 ft. to 9 ft. in depth (Ibid., p. 22): "Within the above limits . . . the deeper the filter, the greater is the relative purification effected per cube yard of filtering material." It is surprising that Mr. Fuller, by the use of the same formulæ, should arrive at a diametrically opposite conclusion. It may be that they are not applicable under all conditions at sewage treatment plants in this country.

* Author's closure.

The method used by Dr. McGowan in arriving at these formulæ appears to be based on sound reasoning. There is a wide variation, however, in the value of the constants used in the formulæ as determined from tests upon different sewages, and Dr. McGowan states that the results are only approximate. He points out also that it is necessary to make corrections for certain sewages containing trade wastes. It may be that the formulæ should be radically modified when applied to Gloversville and Worcester, both of which cities contain unusual amounts of trade wastes.

It is certainly a fact that in the case of Filters G and H at Worcester, which, in Table 4 of Mr. Fuller's discussion, show 8 200 and 8 350 "purification units" per cubic yard per day, respectively, Filter G accomplished distinctly more work than Filter H. These filters differed only in the size of filtering material and during the period in question received almost identical quantities of comparatively fresh sewage from the Imhoff tank. The analyses quoted by Mr. Fuller show that the purification effected by Filter G was distinctly greater than that accomplished by Filter H, in spite of the fact that the "purification units" ascertained by Mr. Fuller by the application of the Royal Commission formulæ indicate the reverse to be true.

We have checked up Mr. Fuller's computations in Table 4, and find that the strength of the effluent from Filter G should probably have been 6.9 instead of 7.9, in which case the reduction in strength would have amounted to 86.8 units instead of 85.8, and the "purification units" per cubic yard per day would then be 8 330 instead of 8 200. After making this correction, however, the results would still indicate that Filter H had done somewhat more work than Filter G, which is contrary to the facts.

In obtaining these results for Filters G and H, Mr. Fuller has assumed that the oxygen consumed by the two-minute boiling test is equivalent to that which would be obtained by the English four-hour test, whereas comparisons made by Mr. Lanphear at Worcester show that the four-hour test gives results approximately one half those obtained by the two-minute boiling test. This correction would reduce the "strength"

of the influent about 40 per cent. Mr. Fuller has also omitted the factor of volatile suspended matter from the formula for calculating the strength of the effluent, which correction still further reduces the "purification units." The comparison of Mr. Fuller's values with our corrected values is as follows:

Purification Units per Cubic Yard per Day.

	Filter G.	Filter H.
Mr. Fuller's computations	8 330*	8 350
Corrected values	4 270	4 265

The "corrected values" change the relative purification effected by the two filters only slightly, but they show the need of caution in applying the Royal Commission formula.

In Table 3 of Mr. Fuller's discussion, it would appear that the 5-ft. Filter D at Worcester accomplished decidedly more work than the 7.5-ft. Filter F of the same material. Only 70 per cent. of the effluent samples from Filter D were stable, against 93 per cent. of the effluent samples from Filter F. If the same load per cubic yard had been applied to Filter F that was applied to Filter D, the number of "purification units" would have been quite different. A similar statement is made in the discussion on page 21 of Appendix 4 of the Fifth Report of the Royal Commission, which reads as follows: "At Leeds the purification effected was much less than at the other five places because the filter was not working up to its full power."

In the case of the Gloversville data presented in Table 2 of Mr. Fuller's discussion, too much value again appears to be indicated for the filter producing the poorest effluent. We call attention to the fact that whereas the 5-ft. filter shows approximately 50 per cent. higher value for the "purification units" than the 10-ft. filter, the quality of the two effluents is hardly comparable. Only approximately 37 per cent. of the samples of effluent from the 5-ft. filter passed the putrescibility test against 91 per cent. of the effluent samples from the 10-ft. filter, and 53 per cent. of the effluent samples from the 7-ft. filter.† In this connection we will quote again from the Fifth Report of the

* As corrected by H. P. E.

† See Gloversville report, p. 111.

Royal Commission, Appendix 4, page 27, referring to the use of the formulæ proposed for ascertaining the "purification units," which reads as follows: "It must, however, be clearly understood that this proposal is only meant to apply to the case of good, or at all events, fairly good effluents. In the case of a bad effluent, it may be misleading, for as a general rule the more sewage liquor passed through a filter with a poor result, the greater the number of units of purification by this method of calculation."

Turning now to the Baltimore results in Table 6 of Mr. Fuller's discussion, we note that while the 6-ft. filter accomplished 20 per cent. more work than the 9-ft. filter by the "purification units," the relative stability, according to the Baltimore report cited (Table G, p. 67), was 20 per cent. higher in the case of the 9-ft. filter. There is much less difference between the character of the effluents from the 9-ft. and 12-ft. filters, which would indicate that the 9-ft. filter was the more economical. These filters, however, were in operation less than a year (August 1, 1907, to May 8, 1908), and it could hardly be expected that they would reach a condition to do their maximum work in this period of time, particularly in the case of the deeper filters. Examining the results of putrescibility tests in Appendix 2 (Table 5) of the Baltimore report, we find that in the case of the 9-ft. filter all but one of the effluent samples, after January 20, did not putrefy at all, and the same thing was true of the 12-ft. filter after January 6. In the case of the 6-ft. filter, however, less than 75 per cent. of the effluent samples after January 1 remained non-putrescible. In the case of the deeper filters it would appear that the purification was carried further than necessary to produce a non-putrescible effluent. How much further, the putrescibility test does not reveal. If the extent of purification sought be a non-putrescible effluent, a greater load could have been put upon the deeper filters with satisfactory results.

In Table 7 of Mr. Fuller's discussion, it appears that a 4.5-ft. filter at Baltimore accomplished 30 per cent. more work by "purification units" than a 7.5-ft. filter. The effluent from the 4.5-ft. filter was unsatisfactory, however, if we take a non-

putrescible effluent as the standard, the relative stability being only about 55 per cent., as shown in Table G, p. 68, of the Baltimore report. The purification accomplished by the 7.5-ft. filter is 24 per cent. greater than that accomplished by the 10.5-ft. filter, according to the "purification units," but the "strength" of the effluent from the 7.5-ft. filter is 73 per cent. greater than that from the 10.5-ft. filter.

An examination of the Lawrence data in Table 5 of Mr. Fuller's discussion shows that the 10-ft. filters produced much higher nitrification than the shallower filters, and that the "strength" of the effluent from the shallower filters is many times that of the 10-ft. filters. If the load upon the 10-ft. filters had been increased so as to give effluents of substantially the same quality as those from the shallower filters, the "purification units" accomplished by the 10-ft. filters would undoubtedly have been very materially increased and it seems quite probable that these values would equal or exceed those given for the shallower filters.

To summarize, we believe that our studies show that the English formulæ are not applicable to the wide range of conditions covered in Mr. Fuller's discussion and lead to erroneous conclusions.

Mr. Fuller states that the conclusion of the Royal Commission that the work accomplished by trickling filters is substantially the same per volume of material were presumably obtained with stale rather than with fresh sewage. In their "General Conclusions as to the Working Power of Different Types of Filter," on page 117 of the Fifth Report, the Royal Commission state with reference to well-settled sewage, "In this case, therefore, the process is comparable with the treatment of septic liquor upon percolation filters." The Royal Commission make no distinction between fresh and stale sewage, but it is fair to assume that the above statement applies to all conditions from comparatively fresh to extremely septic.

Our method of comparing the work done by trickling filters of different depths was to ascertain the relative stability of the effluents when equal loads of unoxidized nitrogen per cubic yard of filter were being applied. We recognize that this is an arbi-

trary method, but we fail to see why it should lead to erroneous conclusions when applied to the same kind of sewage for a given locality. As a means of comparing filters of different depths in different localities, it might not be applicable.

In order to make our depth comparisons, we were obliged to select periods in which the loads applied per unit volume of filter were as nearly alike as possible. The periods referred to in Table 1 were as follows:

Locality.	Filter No.	Period of Operation.	Reference.
Gloversville, N. Y.	3	Aug. 29–Oct. 22, 1908	Gloversville Rpt., Append. K
Gloversville, N. Y.	2	Sept. 2–Oct. 22, 1908	Gloversville Rpt., Append. J
Gloversville, N. Y.	1	*Oct. 20–June 28, 1908	Gloversville Rpt., Append. I
Worcester, Mass.	D	Sept., 1909–Sept., 1910	Worcester Sewer Dept. Rpt. 1910, p. 748
Worcester, Mass.	F	Sept., 1909–Sept., 1910	Worcester Sewer Dept. Rpt. 1910, p. 748
Worcester, Mass.	E	†Aug. 18–Nov. 26, 1909	Worcester Sewer Dept. Rpt. 1909, p. 1049
Worcester, Mass.	H	Aug.–Nov., 1911	Worcester Sewer Dept. Rpt. 1911, p. 511
Worcester, Mass.	G	Aug.–Nov., 1911	Worcester Sewer Dept. Rpt. 1911, p. 510
Lawrence, Mass.	247	1904–1906	State Bd. of Health Rpt. 1908, p. 378
Lawrence, Mass.	248	1904–1906	State Bd. of Health Rpt. 1908, p. 378
Lawrence, Mass.	248	1907–1910	State Bd. of Health Rpts. 1908, p. 378; 1909, p. 298; 1910, p. 258
Lawrence, Mass.	135	1904	State Bd. of Health Rpt. 1908, p. 377
Lawrence, Mass.	136	1907 and 1908	State Bd. of Health Rpt. 1908, p. 377
Lawrence, Mass.	136	1909	State Bd. of Health Rpt. 1909, p. 298
Lawrence, Mass.	136	1904–1906	State Bd. of Health Rpt. 1908, p. 377
Lawrence, Mass.	135	1907, 1909, 1910	State Bd. of Health Rpts. 1908, p. 377; 1909, p. 298; 1910, p. 258
Lawrence, Mass.	135	1908	State Bd. of Health Rpt. 1908, p. 377
Lawrence, Mass.	135	1907–1910	State Bd. of Health Rpts. 1908, p. 377; 1909, p. 298; 1910, p. 258

* Given as three months in Table 1 instead of eight months, by typographical error.

† Given as one year in Table 1 through an error in copying.

Mr. Fuller suggests that our general conclusion based on Gloversville and Worcester may not be justified on account of the fact that the sewage of these two cities contains unusual amounts of manufacturing waste. In this connection we might state that the Royal Commission in arriving at the same conclusion considered the results obtained at Birmingham, Bradford, Leeds, Leicester, Manchester and Sheffield, all of which have substantial amounts of manufacturing wastes of one kind or another in their sewages.

Mr. Fuller states that our data are at variance with those from Baltimore and those from Hanley and Leeds, England, as summarized by Kinnicutt, Winslow and Pratt, p. 332. In regard to Baltimore, we are unable to apply our method of comparison to the results obtained from the trickling filters of different depths because similar loads were not applied per unit volume of filtering material. We do not consider that the Baltimore results prove that filters 10 or 12 ft. deep will not produce a non-putrescible effluent at as high a rate of dosing per unit volume of filtering material as can be applied to shallower beds.

The Hanley filters cited by Mr. Fuller were composed of $\frac{1}{8}$-in. to $\frac{1}{4}$-in. filtering material, 1 ft., 2 ft., 3 ft. and 4.5 ft. in depth, respectively. These filters are not applicable to this discussion on account of the shallow depths and the small size of material. In the case of a sand filter, the suspended matter of the sewage applied must be retained very largely at or near the surface of the bed and it can never be carried through the filter. In the case of a trickling filter of coarse material properly operated, the suspended matter is carried down into the bed, and after certain bacterial changes have come about it is eventually discharged with the effluent. This is one reason why a trickling filter may be able to accomplish the same amount of work whether it is arranged in the form of a shallow or as a deep bed. With such fine material as used in the Hanley filters referred to above, surface clogging is quite certain to result.

The Leeds filters cited by Mr. Fuller were of coarse coke 3.5, 2.5 and 2.5 ft. deep, respectively, one above the other and were operated for a period of six months with crude sewage.*

* See Royal Commission, — Fifth Report, p. 70.

These filters were dosed with the same quantity of unsettled sewage per unit of area and the effluent from the total depth of 8.5 ft. was still a very unsatisfactory one. We do not understand that these results are at variance with our conclusion. It is, of course, a fact that the bulk of the suspended matter of the crude sewage was retained in the upper filter.

It is pretty generally agreed that sewage should be well settled preliminary to its treatment by trickling filters. We had understood that the chief trouble from clogging at Reading was due to an abnormal amount of suspended matter being carried out of the large settling tank at Milmont on account of the septic action in this tank during the summer and fall. It is true that there is a greater tendency towards surface clogging with the deeper bed on account of the greater quantity of sewage applied per unit of superficial area, as pointed out in our original paper. Our observations and tests, however, lead us to believe that a 10-ft. filter of fairly coarse material is not too deep if a well-settled sewage of average strength and character is applied with efficient distribution. If the accumulation of clogging matter is such as to prevent the free circulation of air, it will seriously affect the efficiency of the filter. Organic growths may also complicate the situation. Such difficulties can be largely avoided by a proper control of the dosing and resting of the filter. The importance of wise supervision of operation of all trickling filter plants cannot be overestimated.

Mr. Fuller's discussion and application of the McGowan formulæ and the difficulties of applying them to such diverse conditions as herein pointed out, emphasizes more strongly than the writer realized the urgent necessity of experiments such as those being carried out by Mr. Clark at Lawrence. A demonstration of what trickling filters of different depths will actually do when so dosed as to produce effluents of practically uniform quality will be more convincing than the cut and try method of comparison adopted by the writer or the formulæ of Dr. McGowan, which Mr. Fuller prefers. The writer appreciates Mr. Fuller's discussion. It is to be hoped the work described by Mr. Clark will be continued by him and that similar tests, if possible on a somewhat larger scale, will be undertaken by others.

Vol. II MAY, 1915 No. 5

BOSTON SOCIETY OF CIVIL ENGINEERS
FOUNDED 1848

PAPERS AND DISCUSSIONS

DISCUSSION OF INSURANCE AS AN AID TO ENGINEERS.

By Messrs. F. B. Sanborn and N. H. Daniels.

Prof. F. B. Sanborn. — I would like to say a word or two complimenting Mr. Daniels on his review of fire prevention. I believe that general reviews of the essentials of fire prevention help to keep the subject before us and to improve conditions. There are also one or two things that I noted during the lecture that I wish to refer to. One is that I should like to modify the title just a little. Instead of saying "Insurance as an aid to engineers," I would like to put it, "Insurance as a benefit to clients of engineers." I mean by that, that I think the large benefit comes in the saving of money, which is of especial interest to clients of engineers.

I sometimes think that as to engineers' work, this question of fire prevention brings in certain annoying and difficult problems. One is, for example, that an ordinary engineer, working in a consulting capacity and doing a fair amount of work, has a particular design of a plant that involves considerable fire prevention. Shall he try to put that through himself? Shall he have the insurance companies tell him how to do it? Or shall he hire an expert to help him? Certainly if an engineer attempts to do it all himself, and tries to study out many particulars which he may never use again, there is some waste of

time and effort. But as to the assistance that we can get by going to the bureaus, I pretty fully agree with Mr. Daniels. There is much help from that source which can be utilized.

I should like to modify slightly the emphasis that he has seemed to put on the value of labels. As a result of my own experience, which has included eleven years in inspecting work and ten years intermittently in consulting practice, I believe that, theoretically, this idea of labeling is right, and I am not prepared to say that it is wrong in serious respects, but as it is carried out at the present day, I will say that there is much complaint, and consequently I am inclined to be a little incredulous. One common complaint seems to be that labeling has become a monopoly. Another is that it is a dreadfully dragged-out affair; that to put a new article through and have it accepted the first time takes from six months to a year and a half, and that often you have to go to Chicago and push it right through step by step. I realize that Mr. Daniels might say that these stories are probably exaggerated, but I happen to be familiar with the business of one company that is making a product that has to go through this process of approval, and the treasurer tells me that it is a long story to get first approval; and he says that it means an expenditure of considerable money. The question may fairly be raised, Should not the expense of labeling be much reduced?

In large manufacturing corporations like the Amoskeag Mills, the Pacific Mills and others, labeling may properly be dispensed with. They can build fire doors just about as well as people who make a business of it, because, as Mr. Daniels has pointed out, they can get specifications from the insurance companies, and they can put men on that work who will be on it frequently, perhaps make ten or a dozen doors every year. Those doors won't be labeled but they will be all right. Perhaps I have made my emphasis too bold. All I wanted to modify from what Mr. Daniels said would be that as a rule if one was not fully familiar with details he might select labeled doors, but I wouldn't make the requirement for labeling too sweeping.

Now, on the cost of insurance: I didn't get fully the cost for the plant that Mr. Daniels showed and mentioned $49. Do I

understand that \$490 is the cost per hundred thousand dollars of insurance?

MR. DANIELS. — I am not entirely sure as to the amount of insurance carried. I was merely speaking of a lump sum that it cost a particular station. I only meant to say, of course, that under those conditions it might have cost that particular company \$400 a year. It is actually costing \$49 a year on the amount that it is carrying.

PROFESSOR SANBORN. — I wasn't sure but you meant a rate. I understand that the cheapest rate you mentioned is seven hundredths of one per cent., and the highest rate is some other per cent.; the average rate for power houses, I assume, is perhaps one per cent., or \$1 000 for \$100 000. This is high compared with the amount that is paid even on large cotton mills. Take those even like the ones that burned in Salem. Their cost for insurance is less than \$100 per \$100 000 insurance, and I think power houses are paying an excessive amount on insurance, due to the fact that a great many power plants have to place this insurance through some of the insurance bureaus that have kept the rates up too high. In the Factory Mutual Companies, where we get the cheapest insurance, the cost would be about one tenth of 1 per cent., but they are not inclined to take city power plants; they take principally power plants of large manufacturing interests.

In closing, I wish to emphasize one element of good fire prevention which Mr. Daniels touched upon but did not bring out as fully as I would like to see it. Besides the three essential elements, namely, construction, occupancy and protection, I would give prominence to a fourth one, — management. You can have the other three things, but, if the plant is not well taken care of, well managed, the risk is increased and a higher rate is apt to be charged. I should emphasize management as a very important factor.

MR. DANIELS. — I want to make one or two observations on the remarks which have just been made.

It is true that there has been criticism of labeled service, and manufacturers occasionally complain of the requirements placed upon them. I have never had occasion to investigate the

matter with care, but in three or four cases which I have looked into the trouble seemed to be as much with the manufacturers and the article which they were trying to have labeled as with the labeled service. The point which I wish to make is that the Underwriters' label is like a trade mark of a well-known concern. You have no question regarding the quality of the article on which you find it. A fire door which is made according to specifications will perform efficient service, but the only men who are sure it is of standard construction are the ones who made the door or who saw it made. You or I or an insurance inspector finding an unlabeled door cannot tell whether it is a good one or not, but when we find one which bears the Underwriters' label, all doubt is removed and we are justified in giving it full credit.

I have purposely avoided saying much to-night about the cost of insurance or methods of reducing it. This is a very interesting and profitable study of itself. We balance the saving in the cost of fire insurance and the reduced chance of fire damage against the added cost due to the better construction. The amount which we pay for fire insurance depends on two things,— the rate and the amount of insurance carried. Evidently as the value of the property becomes greater the amount which we pay because of poor construction increases correspondingly and the amount which can be expended to improve the property becomes correspondingly greater. It sometimes happens that a building is designed having in mind the possibility of extending it from time to time, due to the growth of the business. There may be changes which will reduce the cost of fire insurance which it will not pay to consider at the start as the reduction in insurance is not sufficient to justify the added cost. As the size of the property increases and its value becomes greater, the amount which is paid by reason of the original deficiencies will increase correspondingly until a point is reached where it will pay to make the changes necessary to effect the saving in insurance.

Vol. II JUNE, 1915 No. 6

BOSTON SOCIETY OF CIVIL ENGINEERS
FOUNDED 1848

PROCEEDINGS

NOTICE OF REGULAR MEETING.

A REGULAR meeting of the Boston Society of Civil Engineers will be held on

WEDNESDAY, JUNE 16, 1915,

at 7.45 o'clock P.M., in CHIPMAN HALL, TREMONT TEMPLE, BOSTON.

Prof. Charles F. Binns, M.Sc., Director of the New York State School of Clay Working and Ceramics at Alfred University, Alfred, N. Y., will address the Society on "The Application of Clay Products to Some Engineering Problems." Lantern slides will be used to illustrate the lecture.

Through the courtesy of the Sanitary Section, this address is given at a regular meeting of the Society.

S. E. TINKHAM, *Secretary.*

PAPERS IN THIS NUMBER.

Current Discussions.

Paper.	Author.	Published.	Discussion Closes.
Elimination of Grade Crossings.	L. B. Reilly.	April.	Aug. 15.
Ground Water Supplies.	W. S. Johnson.	May.	Aug. 15.

Contributors are hereby notified that proof will not be submitted to them for examination unless requested before the 10th of the month preceding the month of publication.

MINUTES OF MEETING.

Boston, May 19, 1915. — A regular meeting of the Boston Society of Civil Engineers was held this evening at Chipman Hall, Tremont Temple, and was called to order at 8 o'clock by the President, Charles R. Gow. There were 102 members and visitors present.

By vote the reading of the record of the last meeting was dispensed with and it was approved as printed in the May Journal.

The Secretary reported for the Board of Government that it had elected the following to membership in the grades named:

Members — Messrs. Horace Thomas Almy, Edwin Packard Bliss, James Edgar Borden, Albert O. Bullard, Russell Burroughs, Horace H. Chase, Charles R. Chevalier, Arthur S. Clapp, Frank Lemuel Clapp, Frederick Otis Clapp, Frederick Howe Clark, Harry B. Collins, Guy Spalding Deming, Alfred N. Denley, Walter A. Devine, William B. Durant, Joseph W. Farwell, Jr., Samuel Jones Fowler, Stephen DeM. Gage, John F. A. Giblin, John J. Harty, Jr., Ralph Warren Horne, Charles F. Joy, Jr., John Stevens Lamson, Herbert D. Leary, Arthur V. Lynch, Ernest W. McMullen, Robert W. Mawney, Arthur J. Maynard, Buckingham Miller, Fred William Morrill, James Henry O'Connor, Robert Heywood Parke, Ralph Farnham Rhodes, Carl Gee Richmond, Henry C. Robbins, Clarence H. Rooks, George Fuller Webb, Harold C. Whitmore and Frederick C. Williams.

Associates — Thomas P. O'Neil, John Edgar Simmons and Harry L. Whitney.

Juniors — Chauncey Davis Bryant, Frederick P. Donovan, Harold W. Putnam and Howard Haven Terhune.

The Secretary announced the deaths of three members of the Society: Past President Alexis H. French, who died May 3, 1915; Walter Jenney, who died May 3, 1915, and Edmund K. Turner, who died May 6, 1915. By vote the President was requested to appoint committees to prepare memoirs. The President has appointed as committee on memoir of Past President French, Messrs. Henry F. Bryant and Edward W. Howe; as committee on memoir of Walter Jenney, Messrs. Richard A. Hale and Arthur L. Plimpton; and as committee on memoir of Edmund K. Turner, Prof. George F. Swain.

The President then introduced the speaker of the evening, Prof. Albert Sauveur, of Harvard University, who gave an interesting talk on "The Structure of Iron and Steel," which was fully illustrated by lantern slides showing the result of microscopical examinations of iron and steel. At its conclusion, on motion of Professor Swain, the thanks of the Society were voted to Professor Sauveur for his very instructive address. Adjourned.

S. E. Tinkham, *Secretary*.

APPLICATIONS FOR MEMBERSHIP.

[June 3, 1915.]

The By-Laws provide that the Board of Government shall consider applications for membership with reference to the eligibility of each candidate for admission and shall determine the proper grade of membership to which he is entitled.

The Board must depend largely upon the members of the Society for the information which will enable it to arrive at a just conclusion. Every member is therefore urged to communicate promptly any facts in relation to the personal character or professional reputation and experience of the candidates which will assist the Board in its consideration. Communications relating to applicants are considered by the Board as strictly confidential.

The fact that applicants give the names of certain members as reference does not necessarily mean that such members endorse the candidate.

The Board of Government will not consider applications until the expiration of twenty (20) days from the date given.

CANNON, MADISON MOTT, Quincy, Mass. (Age 42, b. Brooklyn, N. Y.) Student for four years at Polytechnic Inst. of Brooklyn and for two years at Mass. Inst. of Tech. From 1895 to 1900, engineer in general practice; from 1900 to 1905, engineer with Fore River Ship Building Co.; from 1906 to date, engaged in designing and constructing extensive works along Atlantic coast; is now engineer for H. P. Converse Co., Boston. Refers to E. P. Bliss, F. H. Fay, F. W. Hodgdon and S. E. Tinkham.

EVERETT, FREDERIC ELWIN, Concord, N. H. (Age 39, b. New London, N. H.) Student at Mass. Inst. of Tech., fall of 1896 to spring of 1899. In 1899, draftsman with New England Tel. & Tel. Co.; from 1900 to 1906 with Park Dept., Cambridge, Mass.; from 1906 to date with New Hampshire Highway Dept. as assistant engineer, division engineer and acting highway commissioner. Refers to A. W. Dean, G. F. Hooker, W. B. Howe and J. W. Storrs.

HUNTER, ROBERT CHARLES, Charlestown, Mass. (Age 27, b. Charlestown, Mass.) From 1906 to 1908, rodman and transitman, Town of Brookline, Mass.; from 1908 to 1910, assistant engineer, Empire City Subway Co., New York, N. Y.; from 1910 to 1911, leveler with N. Y. State Highway Comm.; from 1911 to 1915, assistant engineer, N. Y. State Barge Canal; at present civil engineer in private practice, Malden, Mass. Refers to W. A. Devine, F. A. Leavitt, H. A. Varney and C. J. Wallace.

PITCHER, SAMUEL H., Worcester, Mass. (Age 51, b. Barbados, B. W. I.) Received technical education at McGill Univ., Montreal, Canada, 1886. Was for fourteen years assistant civil engineer with the City of Worcester; in private practice as civil engineer for seven years; and is now president of Samuel H. Pitcher Co., Worcester, Mass.; was connected with the abolition of grade crossings, Springfield and Worcester; is M. Am. Soc. C. E. Refers to H. P. Eddy, A. L. Fales and J. W. Rollins.

STRONG, EDWARD OWEN, Needham, Mass. (Age 26, b. Plymouth, Mass.) Student for three years at Worcester Polytechnic Inst., civil engineering course. Was for four years with G. A. Fuller Co., as timekeeper, superintendent and estimator; six months with Monks & Johnson as outside superintendent of construction; one year as general superintendent on construction for Associated Trust; is now junior partner of S. R. Troy Co., Boston. Refers to W. M. Bailey, Benjamin Boas, B. S. Brown, F. H. Dillaby, George Taylor and E. O. Tucker.

LIST OF MEMBERS.

ADDITIONS.

Almy, Horace T.	City Engineer's Office, Providence, R. I.
Bliss, Edwin P.	88 Broad St., Boston, Mass.
Borden, J. Edgar	194 Winter St., Fall River, Mass.
Brackett, Leroy G.	86 Sycamore St., Somerville, Mass.
Clapp, Frank L.	195 Boston St., Boston, Mass.
Clapp, Frederick O.	City Hall, Providence, R. I.
Clark, Frederick H.	338 City Hall, Springfield, Mass.
Coburn, Raymond W.	Kendal Green, Mass.
Collins, Harry B.	185 Davis Ave., Brookline, Mass.
Deming, Guy S.	66 Broadway, Lowell, Mass.
Durant, William B.	Turners Falls, Mass.
Gaudreau, Lucien E. D.	55 Central Ave., So. Braintree, Mass.
Giblin, John F. A.	37 Mayfield St., Dorchester, Mass.
Gray, Thomas F.	6 Herbert St., W. Somerville, Mass.
Maynard, Arthur J.	State Farm, Mass.
Richmond, Carl G.	68 Library St., Revere, Mass.
Robbins, Henry C.	88 Broad St., Boston, Mass.
Rooks, Clarence H.	Essex Co.'s Office, Lawrence, Mass.
Sarle, Oliver P.	146 Westminster St., Providence, R. I.
Simmons, John E.	34 So. Central Ave., Wollaston, Mass.
Taylor, Philip W.	745 Main St., Fitchburg, Mass.
Webb, George F.	Peterboro, N. H.

CHANGES OF ADDRESS.

Coburn, William H.	Care of American Woolen Co., Lawrence, Mass.
Lake, Harry E.	High St., North Wilmington, Mass.
Robinson, Harold L.	65 School St., Fall River, Mass.
Walker, Elton D.	138 So. Atherton St., State College, Pa.

DEATH.

Turner, Edmund K.	Died May 6, 1915

EMPLOYMENT BUREAU.

The Board of Government maintains an employment bureau for the Society, to be a medium for securing positions for its members and applicants for membership, and also for furnishing employees to members and others desiring men capable of filling responsible positions.

At the Society room two lists are kept on file, one of *positions available* and the other of *men available*, giving in each case detailed information in relation thereto.

Men Available.

310. Age 26. Graduate of Mass. Inst. of Tech., 1912, civil engineering course. Experience includes work as rodman on railway construction and maintenance and with U. S. Engr. Office, Boston; as timekeeper, paymaster and foreman with Lucius Engrg. Co., Pittsburg, Pa.; and as draftsman with Boston Transit Comm. Desires position with contractor. Salary desired, $4 per day.

311. Age 30. Graduate of Sheffield Scientific School, Yale Univ., 1909, degree of Ph.B., civil and sanitary engineering courses. Experience includes nine months as rodman and transitman with Boston Elevated Railway Co., eighteen months with Pennsylvania Lines West of Pittsburgh on maintenance and grade crossing work, and two and one-half years as civil engineer for Kelley Island Lime and Transport Co., Marblehead, O., work consisting of maintenance of plants and equipment, property surveys, dock construction, etc.; during this time was also engineer, maintenance of way, for Lakeside & Marblehead R. R. Co.; can handle field parties on any survey or construction work. Desires position as assistant with civil or sanitary engineer or corporation. Salary desired, $115 per month.

312. Age 35. Student at Mass. Inst. of Technology for three years course in mining engineering and metallurgy. Has had about thirteen years' experience, including two years on water works and sewerage construction at Panama; seven years on canal construction, Cape Cod Canal; and about four years on surveys, drafting, railroad work, etc. Would like appointment with person desiring his services, to discuss position and salary.

LIBRARY NOTES.

Recent Additions to the Library.

U. S. Government Reports.

Life History of Lodgepole Pine in Rocky Mountains.

Results of Magnetic Observations made by United States Coast and Geodetic Survey in 1913.

Triangulation in Alabama and Mississippi, 1915.

State Reports.

Massachusetts. Report of Public Service Commission on Specifications for Bridges Carrying Electric Railways, 1915.

Michigan. Annual Report of State Board of Health for 1913.

New York. Annual Report of Department of Efficiency and Economy Concerning Matters Relating to Construction and Maintenance of Public Highways, 1915. Gift of Arthur H. Blanchard.

Wisconsin. Geological and Natural History Survey: Polyporaceæ of Wisconsin, by J. J. Neuman; Methods of Mine Valuation and Assessment, by W. L. Uglow.

Municipal Reports.

Brockton, Mass. Annual Reports of Water Commissioners for 1907, 1908, and 1911–14.

Chicago, Ill. Loss of Head Due to Friction in Fire Hydrants, 1914.

Fall River, Mass. Annual Report of City Engineer for 1914.

Fitchburg, Mass. Semi-Annual Reports of Sewage Disposal Commission for 1914.

Gloucester, Mass. Annual Report of Water Commissioners for 1914.

Haverhill, Mass. Annual Report of Water Commissioners for 1914.

Holyoke, Mass. Annual Report of Water Commissioners for 1914.

Plainfield, N. J. Annual Report for 1914.

Woonsocket, R. I. Annual Report of Water Commissioners for 1914.

Miscellaneous.

Boston Elevated Railway Co.: Annual Report of Directors for 1914; Safety on Boston Elevated Railway, 1914.

New International Encyclopaedia, Vols. 9–12.

LIBRARY COMMITTEE.

NEW ENGINEERING WORK.

(Under this head a brief description of new engineering work contemplated or under construction will be presented each month. Engineers and contractors are requested to send descriptions of their work to the Secretary, 715 Tremont Temple, Boston, before 1st of each month.)

United States Government. — NAVY DEPARTMENT. — *Navy Yard, Boston.* — Completion of shipbuilding ways. Erection of four shipbuilding cranes. Equipment of radio station on Naval Hospital grounds in Chelsea.

Commonwealth of Massachusetts.— METROPOLITAN WATER AND SEWERAGE BOARD. — *Water Works.* — The work of laying about 14 000 linear feet of 60-in. cast-iron pipe in Commonwealth Ave. between Prince St. and the Charles River in Newton is in progress under contracts with Andrew M. Cusack, of Boston, and Charles A. Kelley, of Somerville.

Work under contract with John J. Evans, of Lawrence, for laying 24-in. cast-iron pipe is in progress in Washington St., Dorchester Lower Mills.

The painting of the new steel tank on Bellevue Hill, West Roxbury, is nearing completion. The work on the granite masonry tower which is to enclose the tank is now in progress under contract with John Cashman & Sons Co., of Boston.

Sewerage Works. — Work is in progress on the relief outfall sewer at Nut Island and on surveys for the high level sewer to Wellesley.

METROPOLITAN PARK COMMISSION. — The following work is in progress:

Charles River Reservation. — Plans and specifications for construction of a three-arch masonry bridge over the Charles River at North Beacon St., Boston and Watertown.

Furnace Brook Parkway. — Construction of parkway extension from Quincy Shore Reservation to Hancock St., Quincy. John Cashman & Sons Co., contractors.

Nantasket Beach Reservation. — Construction of concrete bulkhead walls. Hugh Nawn Contracting Co., contractors.

Mystic Valley Parkway. — Constructing parkway from Cradock Bridge to Mystic Ave. Coleman Brothers, contractors.

General. — General repairs to roads and treatments with bituminous binders.

DIRECTORS OF THE PORT OF BOSTON. — *Bulkheads.* — The filling is being put in at the south bulkhead, South Boston, and is about 80 per cent. completed.

Boston Transit Commission. — *Enlargement of Park Street Station.* — The interior of the enlargement of the station is being finished in white cement plaster.

Notes on the status of the work on the Dorchester Tunnel and the East Boston Tunnel Extension were printed in the May issue of the JOURNAL.

City of Boston. — PUBLIC WORKS DEPARTMENT, HIGHWAY DIVISION, PAVING SERVICE. — Work is in progress on the following streets:

Frankfort St.,	Neptune Rd. to Bennington St.	Bituminous macadam.
Convent Path,	Breed St. to Gladstone St.	Art. stone steps and wall.
Braintree St.	Franklin St. to Everett St.	Hassam block pavement.
Saybrook St.	Market St. to Dustin St.	Bituminous macadam.
Albano St.,	Washington St. to Amherst St.	Bituminous macadam.
Rosecliff St.,	Washington St. to Kittredge St.	Bituminous macadam.
Barbara St.,	So. Huntington Ave. to Centre St.	Bituminous macadam.
Kittredge St.,	Rosecliff St. to Metropolitan Ave.	Bituminous macadam.
Spring St.,	Gardner St. to Webster St.	Bituminous macadam.
Hillcrest St.,	Elgin St. to Temple St.	Excavating and grading.
Temple St.,	Spring St. to Ivory St.	Excavating and grading.
Basto Ter.,	South St. 322 feet northerly.	Bituminous macadam.
Seaver St.,	Blue Hill Ave. to Humboldt Ave.	Excavating and grading
Seaver St.,	Humboldt Ave. to Walnut Ave.	Excavating and grading.
Wellington Hill Footway,	Wellington Hill St. to Walk Hill St.	Artificial stone steps.
Deering Rd.,	Blue Hill Ave. to Harvard St.	Bituminous macadam.
Fabyan St.,	Blue Hill Ave. to Harvard St.	Asphalt pavement.
Hopestill St.,	Aspinwall Rd. to Southern Ave.	Asphalt pavement.
Dempster St.,	Ruggles St. to Halleck St.	Hassam block pavement.
Neponset Ave.,	Holbrook Ave. to Tolman St.	Artificial stone sidewalks.
Neponset Ave.,	Boutwell St. to Minot St.	Artificial stone sidewalks.
Dracut St.,	Dorchester Ave. to Bruce St.	Artificial stone sidewalks.
Lockwood St.,	Metropolitan Ave. to Huntington Ave.	Bituminous macadam.

The Fore River Shipbuilding Co., Quincy, Mass., has the following work in progress:

U. S. Battleship *Nevada*.

Nine U. S. submarine boats.

U. S. Torpedo Boat Destroyers *Cushing*, *Tucker* and Nos. *63* and *64*.

Two oil-tank steamers.

One molasses tank steamer.

Vol. II JUNE, 1915 No. 6

BOSTON SOCIETY OF CIVIL ENGINEERS

FOUNDED 1848

PAPERS AND DISCUSSIONS

THE SEWAGE DISPOSAL WORKS AT FITCHBURG, MASS.

By David A. Hartwell, Member Boston Society of Civil Engineers.

(Presented before the Sanitary Section, March 3, 1915.)

The city of Fitchburg is situated in a narrow valley nearly semicircular in shape and about six miles long, through which flows the north branch of the Nashua River. The total fall of the river through the city is nearly 300 ft., which is fully developed for power. The first sewers were built in 1868, when the population was about 10 000. As the population increased, sewers were built as needed, until in 1910 with a population of about 38 000 there were 41 miles of sewers. Outlets for these sewers were built to the river at the most convenient and inexpensive locations, and in 1910 there were 27 such outlets in a distance of about 5 miles.

The drainage area of the river at Fitchburg is about 62 square miles, but even with a fair amount of storage of the run-off there was still such a low flow during the summer months that odors, caused by the pollution of the water, were noticeable at a considerable distance from the river. Objections were raised by different manufacturing interests to the pollution of the river by sewage, but only one suit was brought, and that

Note. Discussion of this paper is invited, to be received by Edward C. Sherman, Editor, 6 Beacon Street, Boston, before August 15, 1915, for publication in a subsequent number of the Journal.

was withdrawn before the time of trial. The great need of improving the condition of the river was nevertheless appreciated by the city authorities, but there was, with each administration, a desire to defer as long as possible the large increase in the city debt that would be necessitated by the construction of a main sewer and a disposal plant.

Studies and Reports.

The problem of removing the sewage from the river and providing some form of treatment has been studied at different times. The writer first studied the question in 1895 with the late Mr. Charles A. Allen, of Worcester, and reported to the city council in 1896. It was again studied with the late Mr. Freeman C. Coffin, of Boston, in 1900, and a report submitted in 1901; and still further studied in 1901 with Mr. T. Howard Barnes, of Boston, and a report submitted in 1902.

The recommendations in these three reports were about the same, involving the construction of a main intercepting sewer in substantially the same location, and the disposal of the sewage by intermittent sand filtration with probably some form of tank treatment before filtration. Septic tanks at that time were apparently offering a partial solution of the serious problem of caring for the sludge settled in any form of tank. No construction was attempted, although a city council committee went so far as to ask for and receive the approval of the State Board of Health in December, 1903, of the proposed system as outlined in the Coffin report.

By 1909 the pollution of the river was so excessive and the objections of mill owners and of the State Board of Health were so great that the city council deemed it useless any longer to defer action towards removing the sewage from the river. A bill was introduced by the city council in the legislature, which was enacted as Chapter 461 of the Acts of 1910 and was approved April 28, 1910. This bill authorized the appointment by the mayor of three legal voters to constitute a board of sewage disposal commissioners for a term of office not to exceed seven years. This commission was to have full charge of all work of every nature relative to the sewers and drains of the city,

and also was to construct a main sewer and disposal works subject to the approval of the State Board of Health. This commission was appointed in June, 1910, and the writer accepted the appointment as chief engineer and superintendent on December 1, 1910.

A paper read before the Sanitary Section on February 5, 1913, and published in the *Journal of the Association of Engineering Societies* for August, 1913, described the design and construction of the intercepting sewer, and in this paper I will confine myself to the disposal works.

Volume of Sewage.

In designing the disposal works, provision was not made for caring for the full capacity of the intercepting sewer, which, at the upper end of the siphon, is 30 000 000 gals. per day. The 30-in. inverted siphon, covering the distance of 5 430 ft. immediately above the disposal works, has a capacity of 14 000 000 gals. per day, as indicated by the Venturi meter for a period of six hours. While it is possible to deliver 14 000 000 gals. a day to the disposal works, the plant was not constructed to treat that amount of sewage. The population of Fitchburg in 1910 was 37 826. The average rate of gain for each five years for the thirty years from 1880 to 1910 was 21 per cent., and the average gain for each five years for the twenty years from 1890 to 1910 was 14.6 per cent. With an assumed increase of 15 per cent. for each five years, the population would be 43 400 the present year, 57 400 in 1925 and 87 200 in 1940. At the present time there are about 35 000 people using the sewers, and the flow is about 3 400 000 gals. It was thought best to make provision in designing the Imhoff tanks for a population of 55 000, which would probably be as many people as would be contributing to the sewage flow in 1930 or 1935, owing to a considerable number of the people living at locations without sewerage.

Venturi Meter.

The sewage as it arrives at the disposal works first passes through a 30-in. by 15-in. Venturi meter which is placed under-

ground in a concrete chamber directly at the rear of the laboratory building. This meter is equipped with vent cleaners and hand hole openings on both the upstream and throat pressure chambers. The float pipes are connected with the city water pipe with a small jet opening, so there is a slight movement of the liquid from the float pipe to the meter, thus preventing the sewage from entering the float pipes.

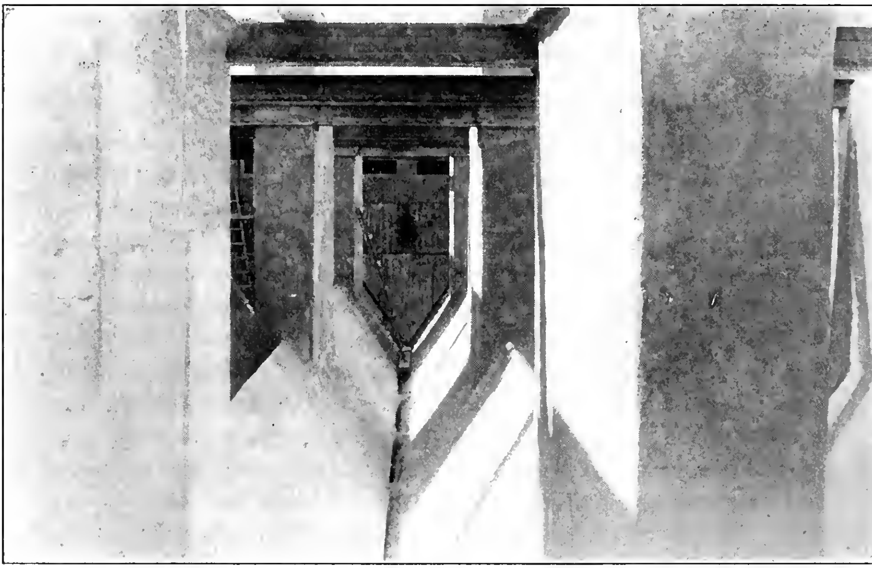


FIG. 1. SETTLEMENT CHAMBER OF IMHOFF TANK.

IMHOFF TANKS.

The Imhoff tanks are five in number, covering an area of about 100 ft. by 160 ft. Each tank is rectangular in plan and 30 ft. by 90 ft. inside measurement. Each tank has three bottoms in the shape of inverted pyramids, with an altitude of 7 ft. 6 ins. The side walls of each tank are 18 ft. 5 ins. high, with a batter on each side of 3 ins., while the end walls are vertical on the inside of the tanks. The extreme height of the concrete of the tanks is 27 ft. The concrete in the tank bottoms is reinforced with rods, and the side and end walls have both rods

and structural steel for reinforcement. The total depth of sewage in the tanks when in use is 24 ft. 5 ins. The influent channel is 30 ins. in diameter, with the invert 5 ft. 9 ins. below water level. Three 12-in. sluice gates connect the influent channel with each tank. The effluent channel is rectangular in shape, 3 ft. 6 ins. wide and 2 ft. 6 ins. deep below the weir plates of the tank. Influent and effluent channels are built at both ends of the tanks to provide for reversing the sewage flow. The side walls of each tank are buttressed inside the tanks, and the end walls are buttressed outside the tanks. The influent and effluent channels are supported on the buttresses of the end walls. All buttresses are built about 10 ft. apart, center to center.

Each tank is divided into an upper compartment for sedimentation, and a lower compartment for sludge storage and digestion, by cement plaster partition walls forming three troughs running longitudinally through the tanks. There is a 6-in. slot at the bottom of each trough, through which the sludge descends into the lower compartment. Each tank is provided with two central gas vents, each 2 ft. by 9 ft., over each of the three bottoms, and additional gas vents are provided 22 ins. wide along both sides of the tank between buttresses.

The sludge digestion compartment was designed to store the sludge for a period of six months on the basis of a production of 7 cu. ft. of sludge per day for each one thousand persons. The sedimentation compartment provides for a settlement period for different flows as follows: For a rate of 3 000 000 gals. per day, 7.3 hours; 4 000 000 gals., 5.5 hours; 5 000 000 gals., 4.4 hours; 6 000 000 gals., 3.7 hours; 7 000 000 gals., 3.2 hours; 10 000 000 gals., 2.2 hours; and with 14 000 000 gals., the capacity of the present siphon line, 1.6 hours. The velocity of flow through the tank would be 16.3 ft. per hour with a rate of 4 000 000 gals., 20.4 ft. per hour with 5 000 000 gals., 24.5 ft. per hour with 6 000 000 gals., 32.7 ft. per hour with 8 000 000 gals., and 57 ft. per hour with 14 000 000 gals.

Dosing Tank.

The sewage flows from the Imhoff tanks through a 30-in. cast-iron pipe to the dosing tank. This tank is about 48 ft. by 74 ft. in plan and is divided into two compartments or tanks having capacities of 44 000 and 48 200 gals. The dosing control consists of two 30-in. Merritt dosing siphons and one Priestman-Beddoes air flush sluiceway 16 ins. by 96 ins., with all necessary air bells and piping. The tanks are constructed with three sides vertical and the fourth side tapered so that the larger portion of the total capacity of each tank can be discharged with a head of 8 ft. on the nozzles, and the flow would be stopped when the head is reduced to 2 ft.

The time of discharge is between five and six minutes, and the rest period between discharges depends of course upon the amount of sewage being cared for. With a rate of flow of 3 500 000 gals. per day, this rest period is about fourteen minutes. When the volume of sewage exceeds a rate of about 5 000 000 gals. per day, the air control which changes the flow from one tank to the other is checked so that only one tank is in use. As it is not intended to dose the present filter at a much greater rate than 4 000 000 gals. per day, whenever the meter indicates a rate much in excess of that, with weather conditions favorable for a large flow for some time, the attendent opens a 20-in. sluice gate connecting the influent channel in the dosing tank with the overflow channel, and thereby prevents excess dosing of the filter. The dosing tank is constructed so that it can be covered with plank or left open as may be desired.

Sprinkling Filter.

The sprinkling filter covers an area of approximately 405 ft. by 223 ft., or 2.07 acres at the bottom and 410 ft. by 228 ft. or 2.14 acres at the surface. With a population of about 35 000 using the sewers, it was decided that the present construction for about 40 000 people, so far as the sprinkling filter feature of the works is concerned, would be sufficient. This will probably be all that will be needed for filter area for five years and possibly ten years. Any additional area needed can prob-

FIG. 2. FORMS, CHANNELS AND CEMENT BRICKS FOR FLOOR OF SPRINKLING FILTER.

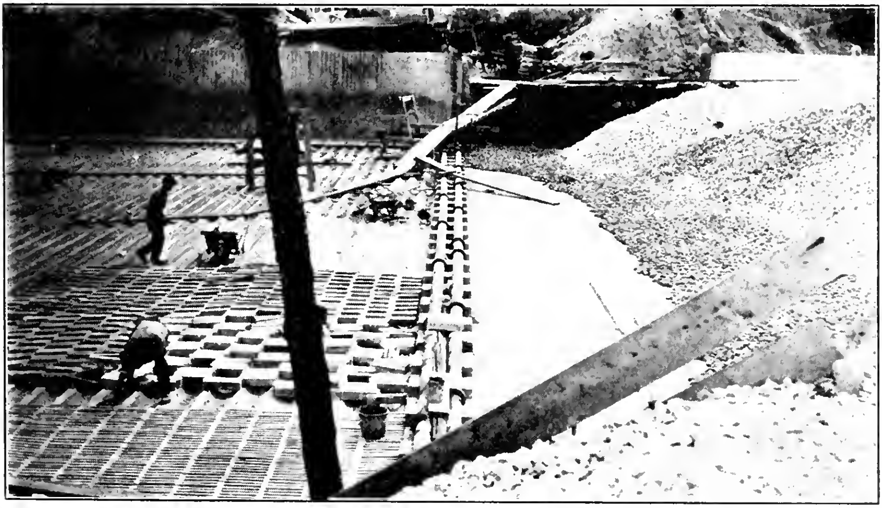


FIG. 3. FILTER FLOOR UNDER CONSTRUCTION.

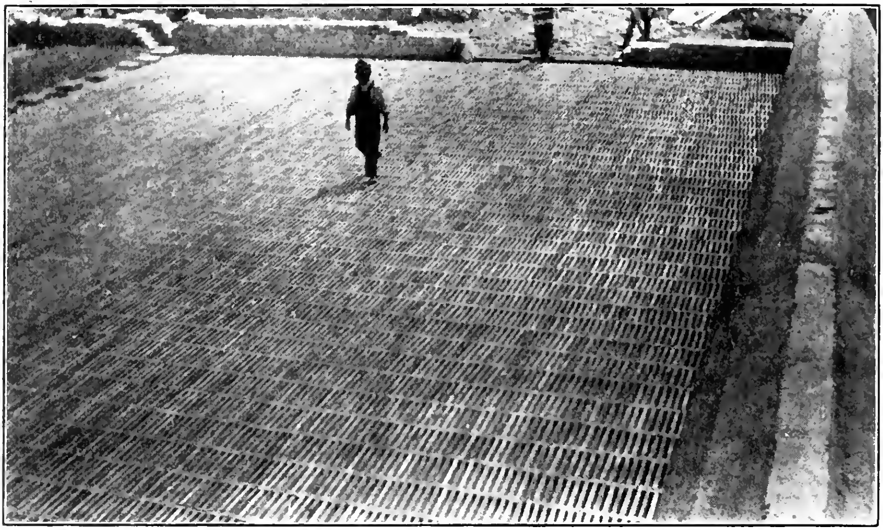


Fig. 4. Filter Floor before Placing Broken Stone.

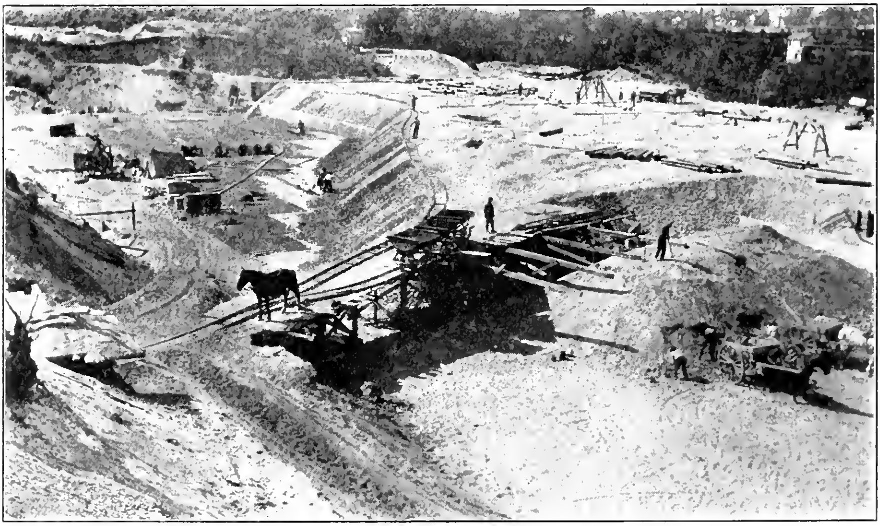


Fig. 5. Placing Stone in Sprinkling Filter.

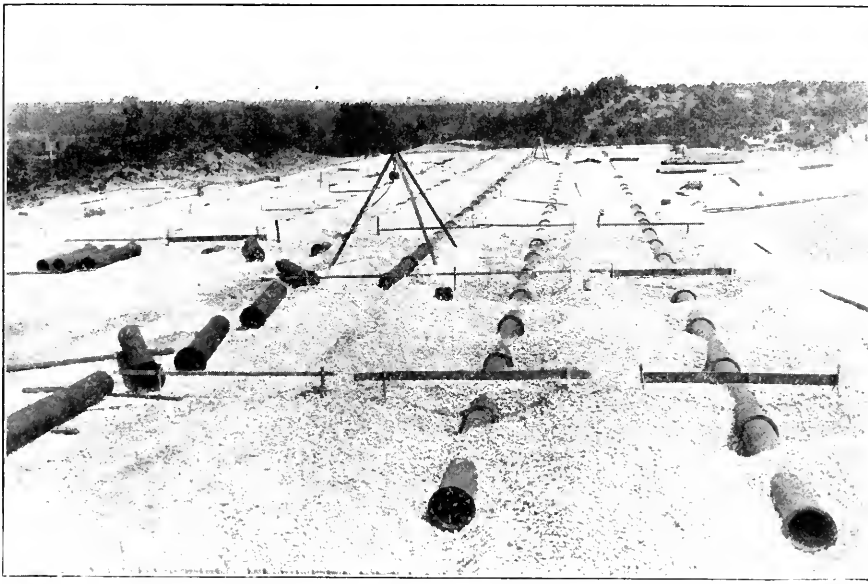


Fig. 6. Distributing Pipes in Filter.

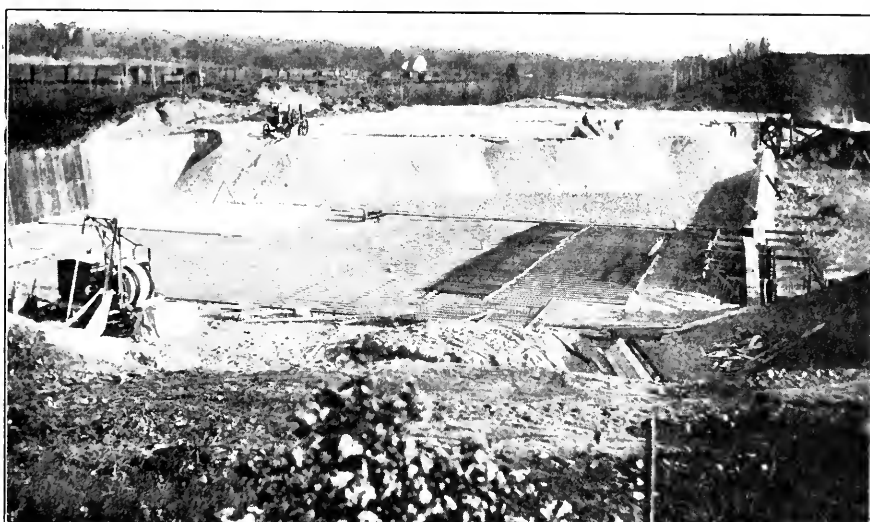


Fig. 7. Sprinkling Filter Construction.

ably be constructed as cheaply ten years from now as at present, with the saving to the city of the interest charges for such a period as the construction is delayed and the additional advantage of an opportunity for studying the operation of the two acres already built for a period of years.

The filter floor is constructed of cement concrete with Clinton wire-cloth reinforcement. The floor drainage consists of troughs or channels spaced 15 ins. on centers and having clear spans of 11 ins. and a depth of 3 ins. The depth of con-

Fig. 8. Sprinkling Filter in Service.

crete in the floor below the trough is 3 ins. Over these troughs were placed bricks made of cement and stone dust to keep the broken stone from falling into the troughs. The stone dust was a by-product from the crusher, and was used in preference to sand, which was also abundant at the works. These bricks were made of one part cement to two parts stone dust. They are 17 ins. by 4 ins. by $1\frac{1}{8}$ ins. in dimensions and as placed in the floor the top surface measured 17 ins. by $1\frac{1}{8}$ ins. This form of floor construction provides a type having 43 per cent. of opening for drainage or ventilation. The blocks were cured about

thirty-six hours in moist air and three weeks in water. In actual service, each block sustains a total load of less than 250 lbs. Tests were made of about two bricks in every thousand, and they would break with a center load of 350 lbs. to 600 lbs., with occasionally a load as high as 1 000 lbs. In all, about 360 000 bricks were used. The floor of the filter is divided by an inspection or flushing gallery 410 ft. long into two equal parts. Each trough or channel in the filter floor has a port-hole or outlet into this gallery about 2 ft. 5 ins. above the gallery floor. The troughs or channels have a slope of 6 ins. from the flushing gallery to the collecting drains at the sides of the filter, the length being about 106 ft. A 6-in. water main, with pressure about 110 lbs., is laid in the gallery to provide water for flushing purposes.

The broken stone in the filter is from 10 ft. to 10 ft. 6 ins. in depth, and the size was specified to pass through a screen having holes 2 ins. in diameter and to be retained on a screen having holes 1 in. in diameter. About two thirds of the stone used was local granite and one third was granite and trap rock brought to the city by railroad. The quarry where the local granite was obtained is located three miles from the filter, and the broken granite was hauled in four Alco trucks. The stone was screened at the filter as well as at the crusher. During 1913 the stone was deposited in the filter by running trucks and carts directly on to the bed with plank protection, but this method was changed, and all stone placed in 1914 was by track and construction dump cars.

The distribution system consists of 17 lines of cast-iron pipe running longitudinally through the bed. These pipes are 16-in. for about one half the length and 12-in. for the remainder. They lead from a header line of 36-in. and 30-in. cast-iron pipe connected with the dosing tank. These distribution pipes are laid in the top of, and are supported by, the broken stone, the top of the pipes being just below the surface of the stone. Three hatch boxes are placed in each pipe line, and provision is made for draining them. The pipe lines are laid about 13 ft. apart on centers, and the nozzles are 15 ft. apart in each line, being staggered so that they are at the vertices of equilateral triangles

15 ft. on a side. Each of the 17 pipes has a gate, so that in case of changes or repairs only one need be shut off, and only one eighth of an acre of filter area would be out of commission. The nozzles are screwed directly into the top of the distributing pipes with no risers. The nozzles used are a modified form of the Worcester nozzle and were purchased of Matthew Gault, of Worcester.

Plaster Walls and Cement-Gun.

Thin partition walls of rib-metal reinforcing lath with cement plaster were constructed in the Imhoff tanks, to separate the sedimentation and digestion chambers, and also completely around the sprinkling filter to prevent sand and gravel from working into the spaces between the broken stone. The metal lath used was the "Rib Truss," manufactured by the Berger Manufacturing Company, of Canton, Ohio. The method of placing the plaster was optional with the contractor, either hand work or use of the Cement-Gun being allowed in the specifications. The contractor decided to use the Cement-Gun, and the result was fairly satisfactory. The plans called for a thickness of 2 ins. on both the partition walls in the tanks and the curtain wall around the filter. The type of lath used has such a heavy body of metal and such a small percentage of area of perforation that there is not as large a bond between the cement plaster on the two sides of the metal as is desirable. The limited area of this bond is such that the plaster breaks away when a not very heavy blow comes upon the wall. Again, in the Imhoff tanks, when an attempt was made to smooth the surface of the plaster by troweling, it was easily loosened from the lath. Some form of metal lath with larger openings would be preferable, but would probably require to be backed with forms to prevent the plaster from shooting through.

Secondary Tanks.

The sewage flows from the filter through a 30-in. conduit and pipe line to the four secondary tanks. These are circular in form and 30 ft. in inside diameter. The bottoms of these tanks are inverted cones with an altitude of 9 ft. 3 ins. The

side walls of the tanks are 14 ft. 9 ins. high and are 15 ins. thick at the bottom and 10 ins. thick at the top. The depth of liquid in the tanks is 22 ft. 6 ins. The tanks are built of concrete reinforced with both rods and structural steel. The effluent from the sprinkling filter enters the secondary tanks through a 16-in. spiral riveted pipe connected with a cylinder of $\frac{1}{4}$-in. boiler plate. This cylinder is 5 ft. in diameter and 12 ft. long. The top of the cylinder is 14 ins. above the water surface in the tank, so the liquid must leave the cylinder through the lower

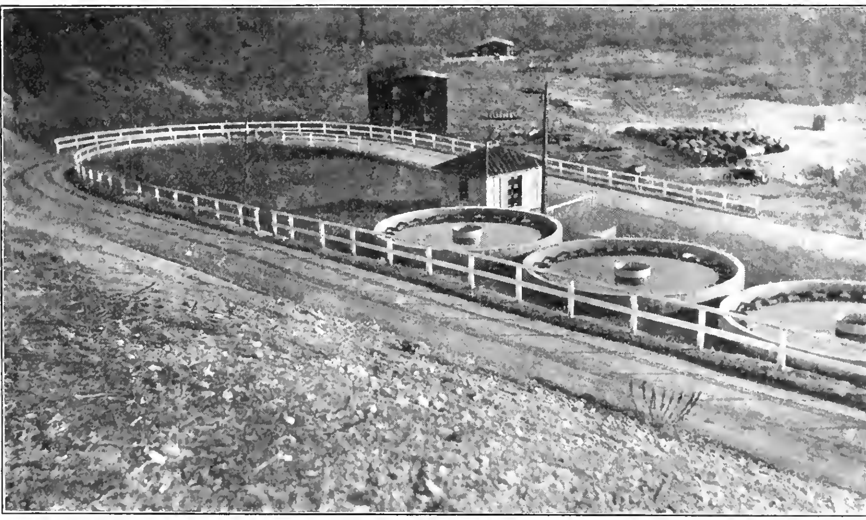


FIG. 9. SECONDARY TANKS AND ROADWAY.

end. Each tank has 24 weirs, each 2 ft. long, over which the liquid flows into a channel which is located within but at the outer edge of the tank. From this channel the liquid flows down a flight of concrete steps into the final effluent channel and then to the river.

Such sludge as will be settled in the secondary tanks will probably be of a character that is slow in drying and objectionable in odor, and for the purpose of caring for this sludge by the least objectionable method it was decided to pump it into the main sewer line at a point between the Venturi meter and the

Imhoff tanks. To do this work, a 5-in. motor-driven pump is installed in a small pump house near the tanks. In pumping sludge from these tanks, which will be done at frequent intervals, everything in a tank will be pumped out so that a thorough

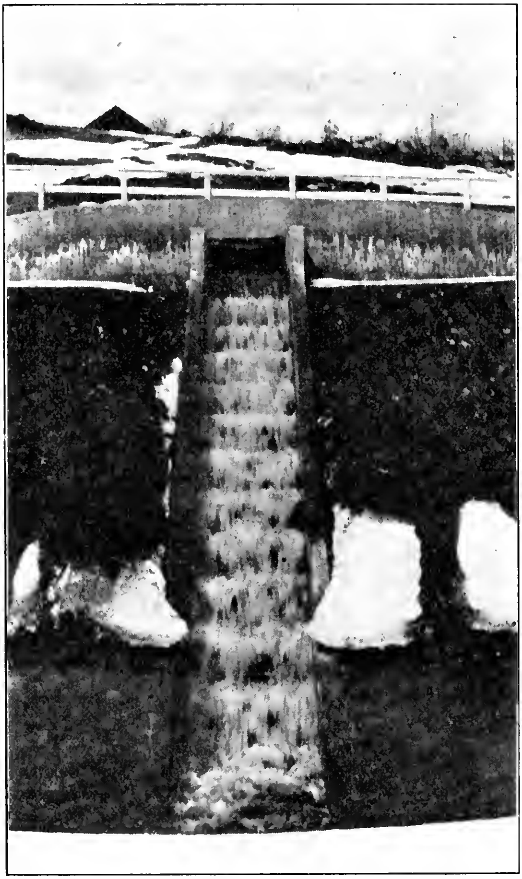


Fig. 10. Final Effluent Flowing from Secondary Tanks.

cleaning can be had if desired. The sludge from these tanks when mixed with crude sewage will probably be digested satisfactorily and all sludge at the works will be of one kind and cared for at one location.

The difference in elevation between the bottom of the secondary tanks and the water surface in the Imhoff tanks is 47.9 ft. Between the sprinkling filter and the secondary tanks is an overflow chamber with a weir at such an elevation as to prevent overflowing the secondary tanks or flooding the filter floor or gallery. Provision in this overflow chamber is also made for passing the sewage direct to the river in case repairs or changes to the secondary tanks may be needed.

Sludge Beds and Pumping.

The location of the Imhoff tanks and filter is such that there is no area near by for a bed upon which the sludge could flow from the tanks by gravity. By pumping the sludge, a suitable location was available immediately adjoining the tanks. The sludge bed is four tenths of an acre in extent and is divided by planks into 11 divisions each about 15 ft. by 111 ft.

In order to avoid breaking up the sludge in pumping it from the tanks, it will be lifted by liberating compressed air in the sludge riser pipe near the bottom of the tank. This air will lift the contents of the pipe above the air outlet, causing sludge to be drawn into the end of the pipe. This process will allow the sludge to flow into the beds in nearly the same condition as it is at the bottom of the tank. An 8-in. sludge pipe is placed in one of the two chimneys above each of the 15 tank bottoms and a gravity flow pipe conducts the sludge from each tank to the sludge bed. The air will be provided by a motor-driven air compressor placed in the basement of the laboratory building. The total lift will be about $8\frac{1}{2}$ ft. The flow of sludge can be directed to different divisions of the sludge area by operation of valves and gates as installed.

Each division of the bed will be provided with an industrial track so that the sludge can be shoveled into cars and pushed to the sludge dump. The area of the sludge bed was fixed at one square foot for each three persons. No underdrains are provided, as the material is such as to make it probable that none will be needed.

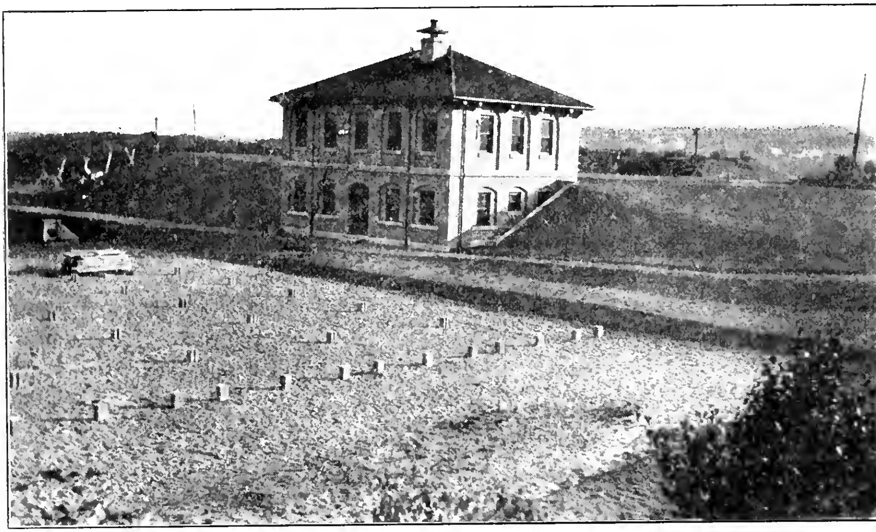


FIG. 11. LABORATORY BUILDING AND SLUDGE BED.

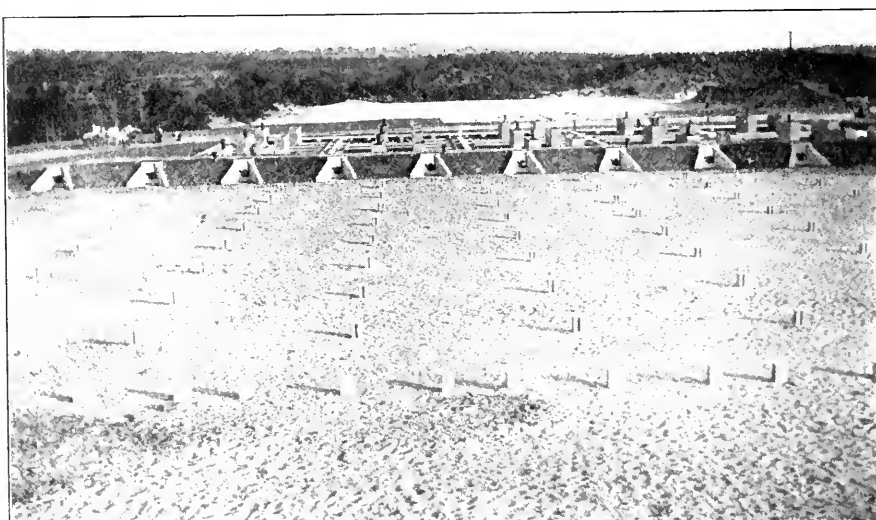


FIG. 12. GENERAL VIEW OF DISPOSAL WORKS.

Laboratory Building.

A brick laboratory building 33 ft. 8 ins. by 43 ft. 8 ins. in plan has been erected at the disposal works. It is one story high in front and two stories in the rear. The basement provides room for tools, cement testing, toilets, heating plant and air compressor. The main floor has the office and laboratories with equipment for thorough analytical study of the disposal processes of the works.

General Features.

In addition to the features already described, there has been constructed about 4 000 ft. of roadway, some of which required quite heavy grading. The river channel has been straightened and improved through the disposal area, and some banks have been protected by riprap. The locations of the various features of the works are such that no pumping is necessary except the air lift for the sludge in the Imhoff tanks and the pumping of the sludge from the secondary tanks to the Imhoff tanks. The water level in the Imhoff tanks is 385.4; the elevation of the top of the sprinkling filter is 375, and the water level in the secondary tanks is 360.

Sewage disposal works are usually located in some low-lying district with naturally unattractive surroundings, and the somewhat imaginary disagreeableness of the work has led citizens generally to avoid the place and to show little interest in the method or upkeep of the works. The Fitchburg works are located largely on comparatively high land and are easily seen from all directions. To make the grounds attractive to visitors and to improve the works from an esthetic point of view, it is proposed to do considerable planting of trees, shrubs and vines and to develop the area immediately adjoining the works so as to create a park effect. This work will not require any large expenditure but will be of benefit and advantage not only to the eye of the visitor, but the tree planting will tend to lift any offensive odors that might arise at any season of the year from any portion of the works. The total area taken for disposal

purposes is 116 acres, but only about 25 acres is used for the present works, and the planting and parking will be limited to that area.

The total length of the intercepting sewer is 5.57 miles, and the total fall in this distance is about 200 ft. The time required for sewage to flow the extreme distance to the disposal works is about three hours, and the time for sewage to pass through the works when the flow is at the rate of 3 500 000 gals. is about eight hours. These conditions make it possible to treat comparatively fresh sewage even with the minimum flow.

Contract.

The contract for the construction of the disposal works was awarded May 15, 1913, to R. H. Newell Company and N. S. Brock, their proposal being the lowest of five received. The estimated amount of the contract was $209 027, and the bond was for $60 000. Work was begun as soon as equipment and material could be assembled, and pushed forward with vigor. As an incentive to speed, the contract provided for a bonus to the contractor provided the work was completed by October 31, 1914, and this bonus, amounting to $5 000, was paid.

The total amount of excavation was 75 500 cu. yds. and the prices ranged from 29 cents to 85 cents per cu. yd. About two thirds of the excavation was at 29 cents. The amount of reinforced concrete was 3 488 cu. yds., and the unit price for nearly all was $11.00 and $11.50 per cu. yd. The number of square yards of cement plaster partition walls was 5 900 and the price was $1.76 in the Imhoff tanks and $1.80 in the sprinkling filter. The amount of bars and structural steel used for reinforcing was 387 000 lbs., and the price in place was 4 and 4½ cents per lb. The amount of broken stone in the filter was 34 052 cu. yds., and the contract price was $1.95 per cu. yd. Cast-iron pipe, gates, valves, specials and other material were furnished by the city and placed by the contractor. The total amount of work done by the contractor by the final estimate was $233 511, which includes considerable additional work not contemplated when the contract was awarded.

Costs.

To any engineer designing a disposal works along similar lines and desiring to make an estimate of cost, a brief statement of costs of this plant may be of interest. As the matter of excavation depends upon the location and condition and would vary widely, I have eliminated all such cost in these figures. The cost of the Imhoff tanks was $52 224, which, based on a population of 55 000, would be about 96 cents per capita. The cost of the sprinkling filter was $122 990, or $58 847 per acre. Based on a population of 40 000, the cost was $2.94 per capita. The cost of the sludge drying beds when completed will be about 5 cents per capita. The cost of the secondary tanks was $8 426, or about 15 cents per capita for a population of 55 000. The cost of the dosing tank was $9 436, or 17 cents per capita. When completed, the disposal works will cost about $320 000, including cost of land, buildings, roadways and incidental work, but not including engineering and inspection. The cost of engineering and inspection for all the Fitchburg work has been 8½ per cent., which would add $27 200 to the cost, making the total $347 200, or $6.31 per capita for a population of 55 000.

Operation of Works.

While the intercepting sewer will not be completed and all connections of present outlets made therewith until July or August of this year, the works have been in continuous operation since October 15, 1914, with such a flow of sewage as came from connections thus far made. The average daily flow from October 15 to December 31, 1914, was 1 742 000 gals., and during the month of January it was 3 761 000 gals. Of this average for January about 2 865 000 gals. passed through the filter. The detention period in the Imhoff tanks has been longer than desirable, being 5.8 hours to 12.6 hours ever since beginning operation, and practically all the matter in the sewage which is capable of being settled has been settled.

The average purification during January as indicated by nitrogen as total albuminoid ammonia was 62.75 per cent. and as indicated by total suspended solids was 87.12 per cent. The

per cent. of suspended solids removed by the Imhoff tanks during January was 68.6. Of the daily 24-hr. samples of final effluent taken for January, 60 per cent. were stable for fourteen days. The nitrates in the final effluent for January averaged 3.8514 parts per million.

The effect of climatic conditions on the efficiency of disposal works of this nature has led some to consider it inadvisable to construct them in a locality having at times so low a temperature as central and northern New England. During this winter there has not been the usual amount of cold weather, so nothing positive can be stated relative to temperature effects. The temperature on the mornings of December 26 and 27, 1914, was about 8 degrees below zero, which is fairly cold for Fitchburg, the coldest for the last twenty years being 17 degrees below zero. On December 28, there was considerable ice on the filter, covering perhaps nearly one half of the surface of the bed, and the secondary tanks were frozen over thick enough to sustain a man's weight. A few days afterward nearly all trace of the ice had disappeared. During this cold period there was a marked decrease in the degree of purification obtained.

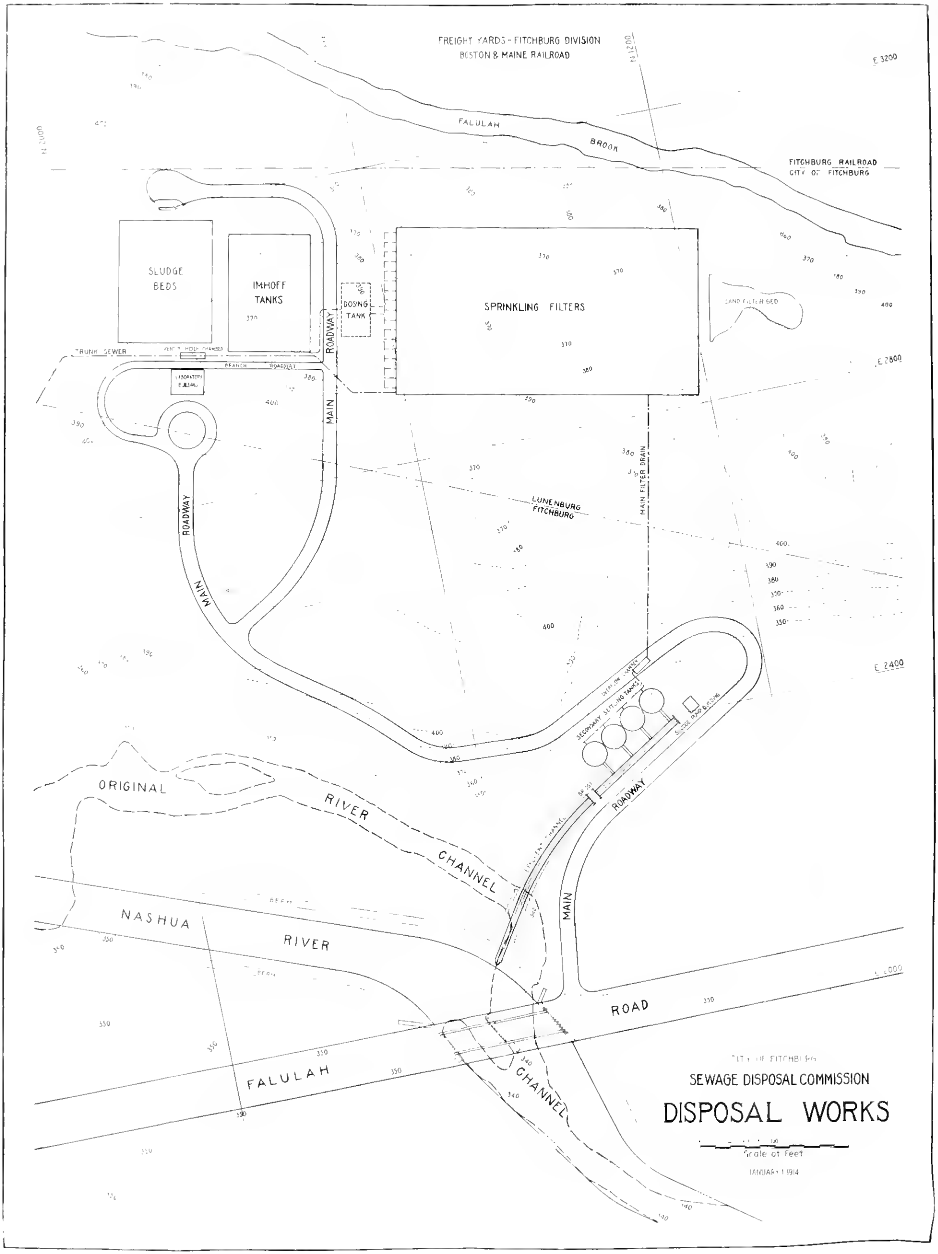

FREIGHT YARDS - FITCHBURG DIVISION
BOSTON & MAINE RAILROAD
FALULAH
BROOK
FITCHBURG RAILROAD
CITY OF FITCHBURG
SLUDGE BEDS
IMHOFF TANKS
DOSING TANK
SPRINKLING FILTERS
SAND FILTER BED
TRUNK SEWER
BRANCH ROADWAY
ROADWAY
MAIN ROADWAY
MAIN FILTER DRAIN
LUNENBURG
FITCHBURG
SECONDARY SETTLING TANKS
ORIGINAL RIVER CHANNEL
NASHUA RIVER
FALULAH ROAD
CHANNEL
E 3200
E 2800
E 2400
CITY OF FITCHBURG
SEWAGE DISPOSAL COMMISSION
DISPOSAL WORKS
Scale of Feet
JANUARY 1 1914

PLATE II
JOURNAL BOSTON SOCIETY OF CIVIL ENGINEERS
JUNE, 1915
HARTWELL ON SEWAGE DISPOSAL AT FITCHBURG, MASS.

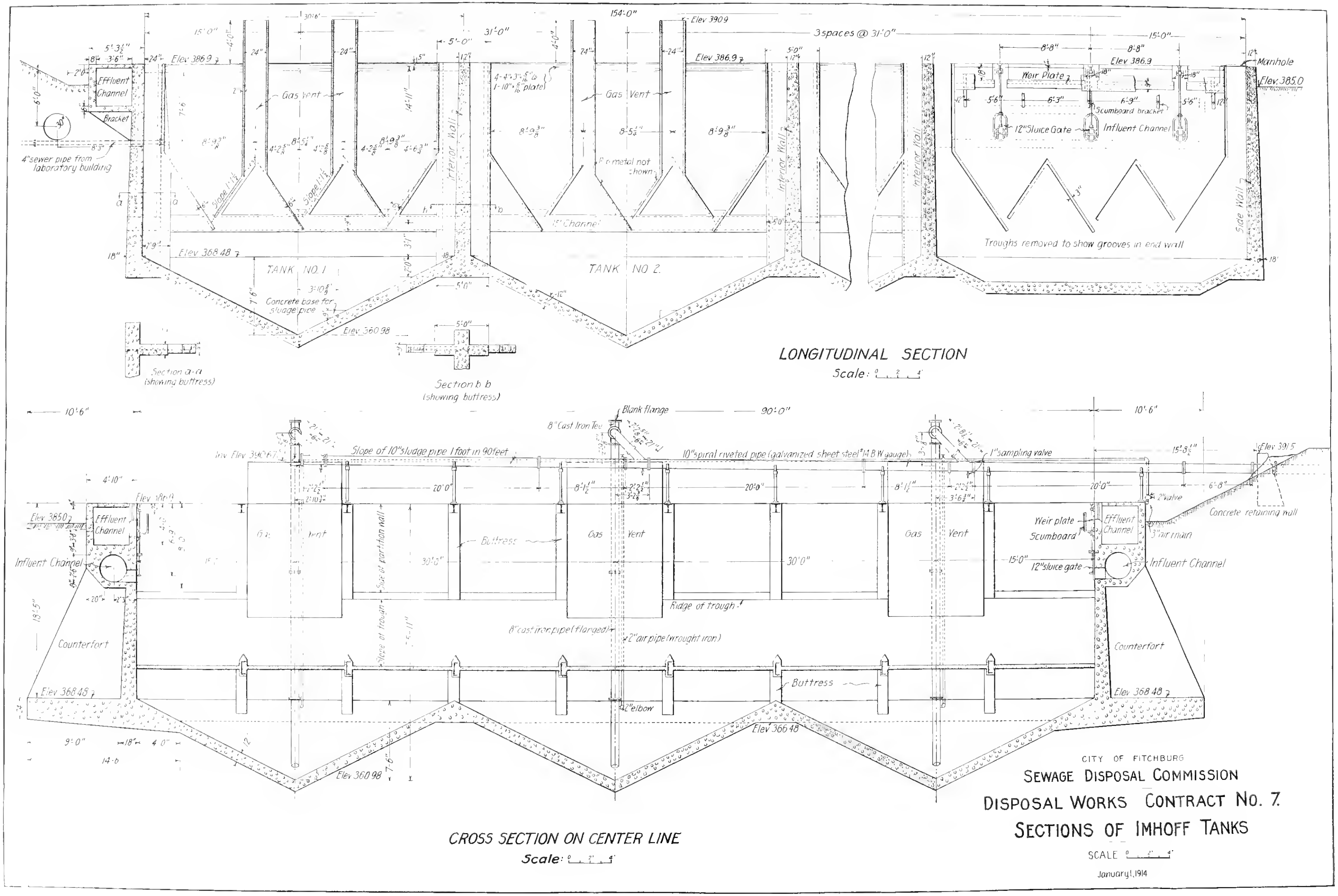


PLATE III.
JOURNAL BOSTON SOCIETY
OF CIVIL ENGINEERS
JUNE, 1915
HARTWELL ON
SEWAGE DISPOSAL
AT FITCHBURG, MASS.

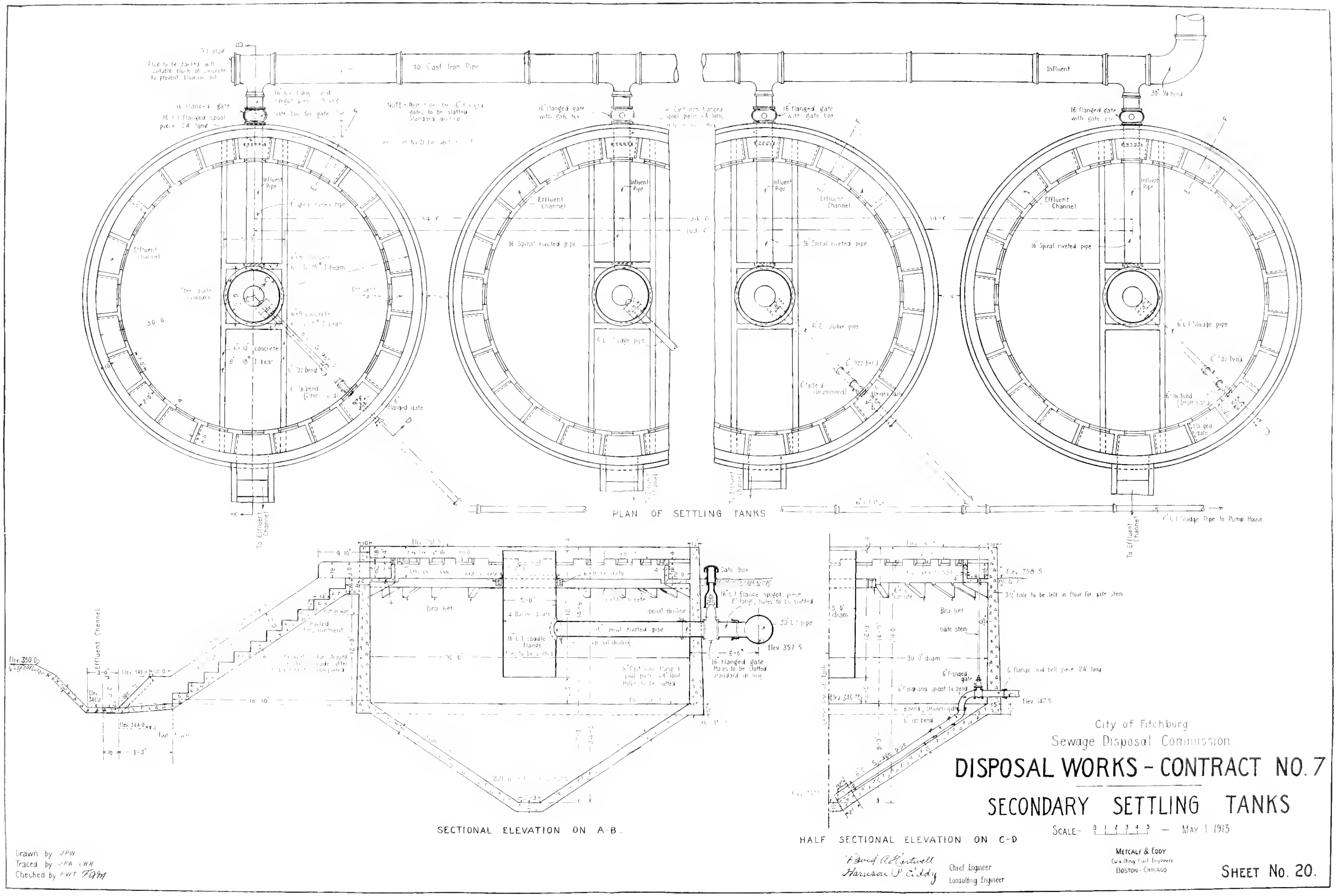
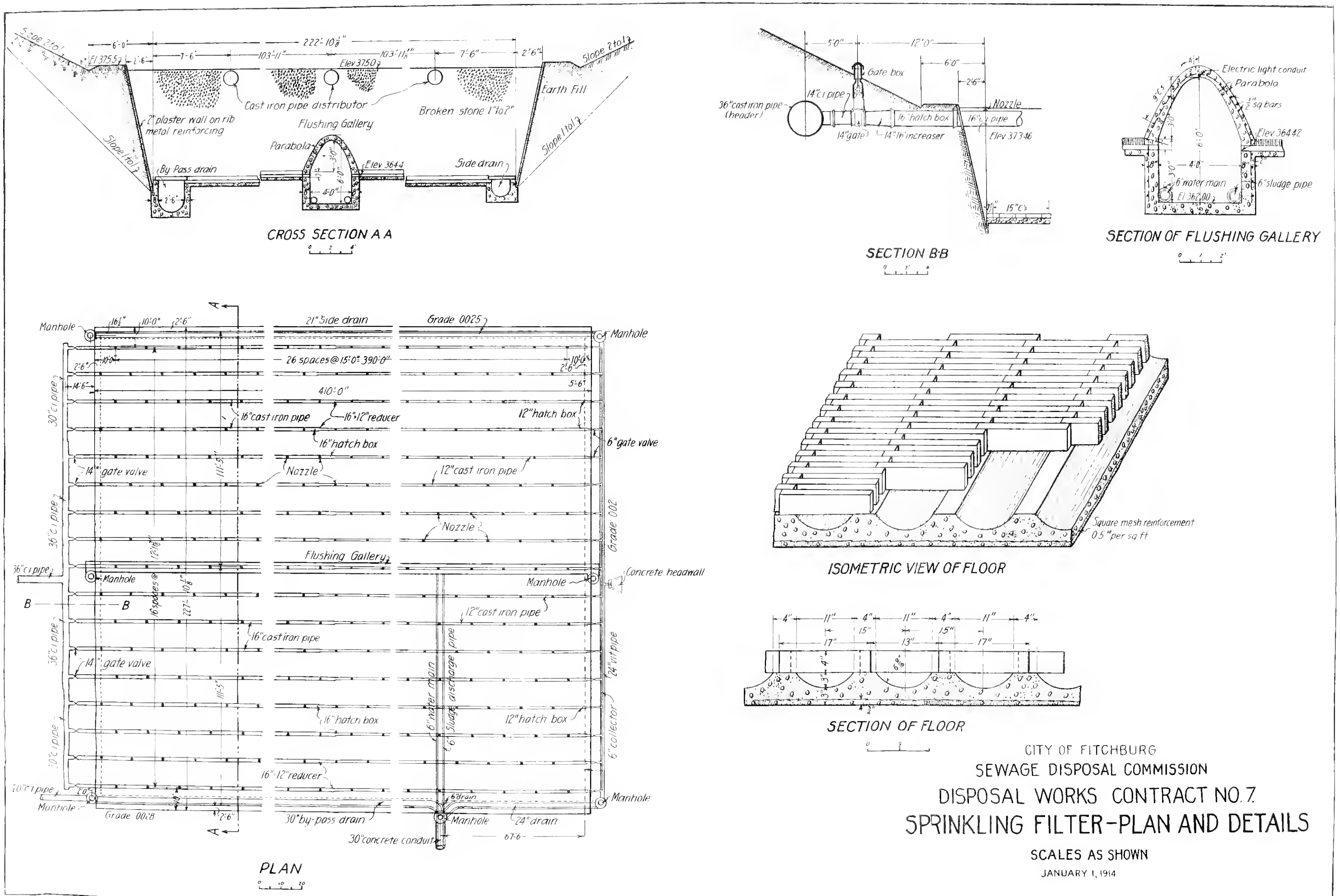


PLATE IV
JOURNAL BOSTON SOCIETY OF CIVIL ENGINEERS
JUNE, 1915
HARTWELL ON SEWAGE DISPOSAL AT FITCHBURG, MASS.



Vol. II JUNE, 1915 No. 6

BOSTON SOCIETY OF CIVIL ENGINEERS
FOUNDED 1848

PAPERS AND DISCUSSIONS

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THE PUBLIC SERVICE CORPORATION AND THE MUNICIPALITY

BY JAMES LOGAN.*

(Presented March 10, 1915.)

THE subject which I have taken for my talk to-night is a live one in every municipality, and is, in my opinion, the largest problem that this country has faced since the days of slavery. It is still an unsettled problem, but it has got to be settled and settled right.

First, permit me to say that I am not a corporation baiter. I am and for years have been the manager of a large corporation, knowing some of the difficulties of corporation management, and I have no sympathy with the thoughtless critic or cheap political demagogue, who pours out indiscriminate abuse upon the public service corporation simply because it is a corporation. Nor do I believe that the hot-air artist and uplifter with neither judgment nor experience will ever remedy our present evils in municipal government or that these questions will be solved by the men at the clubs, who settle these great problems offhand while criticizing men who are giving blood in service.

And let me say I want corporations to make money, and that a public service corporation which is not successful, which

NOTE. Discussions of this paper are printed elsewhere in this number of the JOURNAL. Further discussion is invited, to be received by Edward C. Sherman, Editor, 6 Beacon Street, Boston, before August 15, 1915, for publication in a subsequent number.

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does not earn dividends for its stockholders, is not an asset but a liability to the community which it is supposed to serve, for the reason that an unsuccessful corporation cannot render an adequate service, and service is what it is organized for.— or at least is supposed to be organized for. We must not forget that the public service corporation has been a mighty factor in the development of our country. We are living in an age when business is done on an enormous scale, when we think and do business in large units; and the individual, the firm, or even the small corporation would be as inadequate to conduct the business of the world to-day as the old stagecoach would be to serve as a means of transportation. We are absolutely dependent on the public corporation, and the man who first invented the corporation (and it was an epoch-making invention) conferred upon mankind a blessing second only to the discovery of the power of steam.

It is trite and commonplace to say that the interests of the city and of the public service corporations are so interwoven that they must not be considered separately but together. The public service corporation draws its life from the city, and the modern city could not live without the service which the public service corporation renders. Without the corporation the wonderful development of the world would have been an impossibility. We could not have had the steamship lines which have made the ocean a ferry, the great systems of steam and electric railways, the telegraph, the telephone, gas and electric light. The corporation has been the mighty machine by which the material blessings of this wonderful century of invention have been brought within the reach of the masses, and it has also furnished employment to the millions, so that the means to procure the material blessings have been given to the great family of mankind. The corporation has been the great storage reservoir in which the small savings of the many have been gathered and then in a mighty stream have been turned into the channels through which they have flowed forth to develop a world. By its aid those of small means have had a part in this wonderful development, and without the small savings of the many, progress would have been impossible, and we would not have been able to avail ourselves of the creative

energy of the great master minds of industry and commerce by which so many of the material blessings which formerly were not even within the reach of kings have now become the necessities of the ordinary man.

Now, why is it that the municipality, or the commonwealth even, is at such a disadvantage when dealing with public service corporations? The reason is perfectly simple. Many men are elected as mayors, aldermen and councilmen who know little about municipal business,— or even any kind of business for that matter,— and they find themselves opposed by a lot of trained experts who know every little trick of the trade.

In 1898, when serving on the commission for the abolition of grade crossings in Worcester, the one thing which impressed itself most strongly on my mind was the fearful disadvantage under which the city laboied when dealing with the railroads. The question of grade crossings had hung over the city for years, and each time it came up, owing to changes in the personnel of the city government, it had to be wrestled with by new men who had practically no knowledge of all the past conditions, while opposed to the city were the railroad corporations which had had a continuous management for years and which had a fixed, continuous, persistent, well-defined policy. Their side of the case was conducted by the ablest talent money could hire, by men who were present at the birth of some of the problems, and had seen some of them attain their majority, and who were familiar with every stage of their development. Every move of the grade-crossing commission or city government had to be made out in the open, where all the plans of the city were known and kicked to pieces by our own people, factional, special and personal interests making breaks in the ranks of those representing the city, while on the other side was a solid front, thoroughly entrenched and protected by masked batteries, manned by men who knew every move the city had made or was to make, and who, behind closed doors, could develop their plans to checkmate the city. A decidedly unequal contest.

While I was mayor I had a conversation with a prominent engineer who was interested in our grade-crossing abolition fiom the railroad side and he laughed at some of the things that got

by, and said the City of Worcester would have saved money if it had hired the best available expert engineers in the country to fight its case, even though it might have paid twenty-five thousand dollars or thirty thousand dollars for the service. But one of the troubles of city governments is this,— they are unwilling to pay what expert service is worth, forgetting that the best and highest grade service will usually bring the best results. The City of Worcester had a good city engineer, but this was his first real grade-crossing problem, and on the other side were a body of engineers who had fought to a finish scores or hundreds of grade-crossing problems, and who had a large experience and who knew thereby how to get what they wanted. Again I repeat, it was an unequal contest with about all the advantages on the side of the railroads, and men wonder why the railroads have their own way so much.

The real reform which we should struggle for is not only against law breaking but against law making which is against the common good. That is the seat of trouble at the present time. The special interests do these things, but the laws which they have had passed make their acts legal. Go up to the State House and see the special interests get in their work and the final results will not be a cause for wonder. They draft the bills for what they want, and the drafting of bills is both a science and a fine art. When we say they get in their fine work we do not necessarily mean that legislative committees and commissions are venal and corrupt; not at all, but we mean this,— that the special interests know what they want, are not backward about making their wants known and, when a hearing is held, the opposition is often simply an aggregation of individuals with many minds, with no concert of action and with no thought beyond the present. Arguments are made on both sides of the subject, often by men unused to legislative work, by men who are strangers to the committee or commission, and without special knowledge on the particular subject under consideration. The city rarely comes to the legislature as a unit, there is almost always faction and, on one side or the other, there is almost always a Grouch who comes to kick, and it matters not what it is, he is there with his war paint on, and that Grouch is invariably used

as an asset by the special interests to make for division and the cultivation of bad blood between the several factions representing the city, and, after these men have all had their say and have for the moment stopped wrangling, up comes the trained expert and attorney for the special interests, with all confidence. He opens up his side of the story. He knows every man on the committee or commission, calls them by their given names, dines and smokes with them, and in general is on terms of intimacy with them. He has a close personal knowledge of all legislation bearing on the subject for the past twenty or more years, which the committee or even the commission may not have, and he knows what plans are being made by his clients to reach out and spike down the far future.

The hearing is ended, and the men who attended it, having made their appeals for or protests against the proposed legislation, have gone about their own business. Ah, yes, but when they went home they left that other man on the job, and the rules of his union allow him to work all his working hours, and he does; and, with his intimate acquaintance with the members of the committee or commission, he gets in his fine work, and I do not charge that he is corrupt or that he uses corrupt practices,— though we know they sometimes do,— but he creates an atmosphere that the servants of the people breathe in quite unconsciously until they think as he wants them to think. It is like a man breathing sewer gas — he may be entirely unconscious of it till his whole system has become thoroughly poisoned. The rest is easy. Under those conditions, is it any wonder that the special interests get legislation to their liking? Not at all, when we consider the manner in which legislation is wrought out. For example, a very innocent-looking bill is introduced in the legislature, and care is taken to have it introduced by a very innocent man who sees nothing in it out of the way, and who perhaps feels flattered by being asked to introduce the bill. The municipality whose interests may be vitally affected is often not consulted about it at all; in fact, it often happens that mighty good care is taken that the bill shall be introduced under such a caption and from such a source that the municipality most interested shall not be alarmed. Hearings are often held before the bills

have even been printed, and at the hearings no one appears to oppose the legislation sought. Of course not. They often know nothing about it, so how can they?— but the interests that desire the proposed legislation are there in full force. The vociferous few are on the job to see that it gets by.

There are great perils confronting this republic to-day, and the most optimistic man, if he be a thoughtful man, must seriously consider them. Our fathers founded, or at least they tried to found — and many of them died in the belief that they had founded — a government "of the people, by the people, for the people," and we men of to-day must not permit our government to become a government by class, by wealth or by special privilege; and if our government has been taken away from the people by the special interests, it is our business to get it back again, and it is not going to be an easy job, but it is going to be done. At patriotic gatherings men will applaud every reference to the sacrifices made by the fathers in securing our independence and to the sons for maintaining the integrity of the Union, but the moment some people are asked to sacrifice anything themselves for the public good, they are either too busy, too lazy, too indifferent, too fond of their own ease and comfort or too fond of the almighty dollar to even entertain the proposition and give it one serious thought. They appear to assume that good government can be secured and maintained without any effort and without sacrifice, but they are eternally wrong. No step of progress has ever been made that has not been paid for by some one, and paid for with blood; and if we are to have political freedom some one must pay the cost by rendering service even if the price demanded is personal inconvenience. The men who fought in the Civil War on both sides fought for what they thought was right — and the women who stayed at home and suffered — were a nobler generation than ours, for they gave all they had, even life itself, for an ideal, and we need that to-day both in our business and our civic life.

Many men who are competent, who are able and who have no private interests to protect or advance, will not render service to the city or state, and these, with the men who remain away from the caucus and the polls, are largely responsible for present

political conditions. The men with special interests are on the job all the time, and the neglect of their political duty by so many is the great opportunity for the special interests to get what they want.

We hear much about franchises for public service corporations, and Tom Johnson, a former mayor of Cleveland, said, " The only good franchise is a dead one." The National Electric Light Association said, " The only good franchise is a perpetual one." Some claim that short-term franchises, others that the indeterminate franchises, will solve the problem, but there is one thing that is certain, and that is, that no matter whether franchises are limited as to time, perpetual or indeterminate, as some one else has well said, " The most important features of franchises are the things that are missing, that are not in them." You know in the past the exploiter of the public has acted on the theory that whatever is not nailed down is his, and that he has often amended along this line,— that whatever can be pried up is not nailed down. The public service corporations claim that the indeterminate franchise is the real thing, but what a howl they would put up were the public to ask them to make a change and take indeterminate franchises for the so-called perpetual franchises that they now hold. I say " so-called perpetual franchises" for I have a distinct feeling that some day the people will say that the men who, in their ignorance, gave away the future gave something that did not belong to them. I am minded to make a quotation from a recent address of Delos F. Wilcox, of New York, at a meeting of the American Academy of Political and Social Science in Philadelphia. He said: " The principle of state regulation by permanent commissions was put forward in this country a few years ago as a statesmanlike method of protecting the people from the exactions of the public service corporation, while at the same time giving the corporations a fair deal. We now find that all the corporations have been converted to the idea of regulation. They not only welcome it, but insist upon it. They are so enthusiastic over it that they help write the laws and even sometimes appoint the commissioners."

It takes a good while for a specialist to see all the things that have been left out of or put into a franchise, and the layman,

whether he be a public official or a plain business man who happens to be rendering service, is apt not to see some of the holes at all, until he has fallen into one of them; and it can be said with truth that great care has been used in the preparation of the holes. The early franchises granted by city governments were very simple, and contained practically no conditions. When those early franchises were granted, the city desired the service which the corporations were to render fully as much as the corporations desired the franchises. They were, in the main, granted to public-spirited citizens who had at heart the development of their town or city by furnishing modern improvements, and, incidentally, to make a fair dividend,—but the main thought in those early years was Service. To-day the proposition is more often than otherwise worked from the other end of the problem, the business of the corporation being to exploit the city for dividends, and too often with not so much regard for service.

In those days, when towns and cities were smaller, the giving of a franchise to some citizen by the city fathers was a matter between neighbors and, as it was not going to cost the town or city anything, and it looked as if it would make the place more up-to-date with a car line than without it, they gave their neighbor the franchise. In some cases it was for a hundred years and in some cases forever, and the men who gave it away did not know what they were doing, and the man who got it did not know, as Booker Washington would say, "what had fallen to his pile," for it really had no value at that time.

The franchise which gives the present Consolidated Street Railway Company its rights in the streets of Worcester was originally granted to the Horse Car Company, a corporation made up of a few public-spirited citizens who organized the company not to exploit the city but to render to the city a public service. No one thought much about conditions then; the interests were local and they were dealing with friends and neighbors, and the mind of man could not at that time have framed conditions to cover a modern franchise for 1915. In those early days franchises were very loosely drawn, and as an example let me read the first street railway franchise granted to the horse

car line in the city of Worcester, which is simply a report of a committee on the part of the Board of Aldermen.

"City of Worcester in Board of Aldermen, October 6, 1862.

"*Gentlemen*, the committee to whom was referred the examination of the proposed location of the Horse Railroad have attended to that duty and beg leave to report in favor of that location according to plans and specifications submitted by the corporation, and accompanying this report, to wit as follows:

"Commencing by a main track and spur at a point in Lincoln Street nearly opposite Harrington Avenue, then proceeding through the middle of the street to Lincoln Square at a point nearly opposite Salisbury Mansion, where it is proposed to have a turnout and spur, then passing on in the middle of the street to a turnout nearly opposite old Market Street. Thence passing on through the middle of Main Street to a turnout opposite the Quinsigamond Bank, then passing on through the middle of Main Street to a turnout opposite the Mechanics Hall, then passing on in the middle of Main Street to the intersection of the Pleasant Street and Front Street branches, at or near City Hall, then passing on through the middle of Main Street to a turnout nearly opposite Oread Street, then again passing on in the middle of Main Street to a turnout nearly opposite Freeland Street, thence passing through the middle of Main Street to the termination in a spur and main track at Webster Square nearly opposite the store of Albert Curtis.

"The corporation desire to reduce the hill at New Worcester, if found necessary, five feet more or less, and will do so under the direction and control of the Committee of Highways, which proposition meets the favorable consideration of the committee. The committee also report in favor of the proposed location of the branches — that in Front Street commencing at or near the Western Railroad Station by the main track and spur and passing through Washington Square to Front Street and through the middle of Front Street to its intersection with the Main Street track at or near City Hall, and that in Pleasant Street commencing by a main track and spur nearly opposite West Street and passing through the middle of the street to its intersection with the Main Street track at or near City Hall, all of which is respectfully submitted.

(Signed) Merrick Bemis.
Chas. B. Pratt.

"The committee will also report in favor of granting to the corporation all necessary privileges for constructing and operating the Worcester Horse Railroad."

(Signed) Merrick Bemis.
Chas. B. Pratt.

A copy. Attest:

(Signed) W. Henry Towne, *City Clerk.*

You will note that this report recommends granting to the proposed horse-car line a location on Main Street and on our two next most important streets, Front and Pleasant streets, and you will note *there is not one single condition named in the franchise.* The committee having signed the report, then adds a postscript in the form of a blanket clause which says,— " The committee will all report in favor of granting to the corporation all necessary privileges for constructing and operating the Worcester Horse Railroad," and the record of the Board of Aldermen says,— " Report accepted and recommendations and locations adopted."

There is not a word in that franchise which says that it is to be like the laws of the Medes and Persians, that can never be changed, but subsequent legislation changed it very materially in the interest of the public service corporation when there was taken from the city the right to control its own streets and that control was given into the hands of a public service corporation acting under the rulings of the Railroad Commission at the State House, for that is practically what has been done. Of course I understand that the streets of a city are under the control of the Commonwealth, and that in voting franchises the aldermen act not as aldermen for the city but as state officers for the Commonwealth to grant the franchises.

The law is contained in Section 64 of Part III, page 463, of the Acts of 1906, as amended on page 417, Section 11, of the Acts of 1909, and says,— " The Board of Aldermen of the city . . . may grant a location for the extension of the tracks of such company and prescribe how said tracks shall be laid and the kind of rails, poles and wires and other appliances to be used, but [and here is the nub of the whole proposition] *they shall impose no terms or conditions to such grant in addition to those imposed by general laws on street railway companies in force on the first day of October, 1898, or such as may have been imposed in the grant of original location.*" By that act, the public service corporation being in the pasture, the bars were now put up so the city could not get in. In other words, it mattered not how great a blunder might have been made when the original grant of location was made, the municipality could

not amend the old grant nor could it impose any other conditions in any extensions of the lines, but must go on perpetuating the old blunder, surrendering rights in other streets for all time, simply because the Board of Aldermen in 1862 did not have the superhuman power to draw aside the curtain and look into the future. But, in my opinion, not one member of that Board of Aldermen in 1862 ever dreamed that he was granting perpetual rights to the Horse Car Company in the streets of Worcester. That is what has been read into the grant of the franchise by subsequent legislation and by rulings of the Railroad Commission which was established in 1868 with practically no power as one of its foundation principles. Its power was to be exercised through reason and the creation of a sound public opinion, and that was why it was not given autocratic authority. The hope of the framers of this legislation was that public opinion would be the strongest power for control.

Let me repeat. In 1862 the City of Worcester, through its Board of Aldermen, granted a location in the streets to the gentlemen who organized the Horse Car Company, and the grant of location covered certain streets (but only those streets), and the law now says the conditions in that grant cannot be changed. Granting that, for the sake of the argument, it would be just as much right to say that, because the company used horse cars to begin with, it could never use electricity or anything else. But it does not stop by saying the city cannot change the old franchise. The special interests have, by subsequent legislation, had read into it changes which materially alter that old grant, by saying that no conditions can be imposed on any extensions of the lines other than those named in the grant of original location, so, because in the distant past the representatives of the city government gave a "jug handle" grant to the Horse Car Company on certain streets, the city can never make any new conditions for extensions in other streets, except on the "jug handle" basis, which means giving both handles to the public service corporation. That may be good law, but it is poor common sense, and it is not justice even if the grist was ground out in the atmosphere of the sacred codfish.

The only value that a public service franchise has is given to

it by the people whom it is supposed to serve, and I use that word "given" advisedly because it is a word which accurately describes what municipalities have been doing in the past, and it is high time that the gift enterprise should come to an end. We have in the past been far too generous for our own good. For the future we must be more careful and preserve for our children's children the remnant that is left of the unearned increment in our streets which belongs to them; it is not ours to give away.

Some years ago, in a conversation with Mr. John Hays Hammond, the celebrated mining engineer, I referred to the old Gloucester fisherman who owned a long strip of shore line near Gloucester, and who, when dying, said to his son, "Don't sell any of the shore line, because there will be a lot more people here, and God Almighty has got all through making shore. There ain't going to be any more of that." Mr. Hammond said,—"You have just made the finest conservation speech that I have ever heard, for in a few words you have told the whole story of conservation." There will be a lot more people here and God Almighty has got all through making some other things besides shore, and some of those things that he has completed belong to all the people and not to any special interest.

A franchise is granted to a public service corporation for two purposes, one of which is stated, and the other, while not stated, is understood: First,— to render service to the community. That is stated. Second,— to make profit. That is not stated, but it is understood. In granting a franchise the statement is always made that the reason for granting the franchise is "public convenience and necessity," which fundamental fact is too often lost sight of as soon as the franchise is granted. It is never stated in a franchise that it is granted to the promoters of the enterprise that they may make enormous profits to be divided in dividends or to be put into the plant to create and enhance the value of the stock of the corporation, the value of which is created by the public by whom the franchise has been given.

What gave the franchise its value? The people who bought the goods, whether water, gas, electricity or transportation. They are the ones who created the values and also that intangible asset called good-will, and the public should not be compelled to

pay enormous dividends on its own creation. In an industrial enterprise the conditions are entirely different; the merchant or manufacturer has keen competition and that will determine his return on his capital, and if you do not like his service or prices you can trade elsewhere; but this is not so with public service corporations — you must take their service and pay their price, whether you like it or not. The case would be entirely different if these public service corporations could be controlled by competition, such as regulates ordinary business or commercial corporations. From the existing conditions these grants must in the very nature of things be monopolies or practically monopolies. A city cannot grant franchises to a half dozen street railway companies, telephone companies, gas companies, electric light and power companies, to tear up its streets at their pleasure. To do this would invite a competition that would kill, for competition may be the death as well as the life of business, and in the end the city would have to pay for a duplication of plant and equipment, maintenance and operation, which would mean economic waste. This would mean a competition that would in the end lead to bankruptcy, the bankrupt corporation being bought up by the successful corporation, and the investors in the former would have lost their money and in the end the people who were served by the successful corporation would be called on to pay for the killing, for they would be obliged to pay dividends on the investment which the successful corporation had to make to pay for the killing and burial of their unsuccessful rival.

Now, just because these grants of franchises are in the nature of monopolies, the investors are protected from the competition that kills, their dividends are more sure than in very many industrial enterprises in which investments are made, and, being so protected, they ought to be so supervised and so controlled that they cannot exploit the public as they have done in the past. The financial risk in many of the public service corporations is not now what it once was. The investment is no longer more hazardous than general business, and these enterprises have become as stable as any human institution can be, and with limited risk the dividends should also be limited.

Now to go back a little. The men who were serving the

cities in those early days had no conception of what changes the future would develop, nor did any one else. Men's views were local and they thought in small units, and it is probably true that not one man in a hundred to whom those early franchises were granted ever made a dollar out of one of them. In a multitude of cases those early ventures were failures and the franchises of bankrupt horse car lines were put on bargain counters and marked down, down, down, to next to nothing, and went begging at any price. That is what happened in Worcester. The whole outfit, franchises, trackage, car barns, and rolling stock, in fact body and soul, was sold in 1869 under an order of the court for thirty thousand dollars, and you will note I say it had a soul that went with its material equipment in 1869.

You have no doubt heard men tell, as I have, about the risks of the business, about the large amounts of capital that were sunk in those pioneer ventures, but it is not the men who are in control, to-day, who lost the money, so don't waste sympathy in that direction.

About this time that smooth proposition, the promoter or exploiter, was born. The man with imagination plus, with a vision of future possibilities, the great exemplar of faith which the Apostle Paul in his inspired definition says is "The substance of things hoped for, the evidence of things not seen." And so, as Brand Whitlock, former mayor of Toledo, Ohio, once said, "The promoters fell heir to the enormous social values that were being created in cities, not by the promoters but by all the families who moved in and toiled and wrought and built up the modern city." Now the promoter or exploiter is an oculist. He is a specialist in his line, for he shuts some men's eyes and opens others, and about this time he opened the eyes of a set of men who were just beginning to see that there was, or at no distant date there would be, money in the electric-railway business; and they were, in their line, just as shrewd and sharp as the promoters of the financial interests behind them. These promoters or exploiters were often the political leaders and in some cases the bosses behind the throne, who sometimes selected mayors and aldermen, but whose names did not appear on the ticket of any political party at elections, although they some-

times were the invisible government, just the same. These men were quick to see the power which they held, and as they needed money to use in the business of maintaining a grip on the local political situation they were not slow to grasp their opportunity to work for the financial interests. And so politics became a large factor in the public business as an ally of the special interests, and the era of speculation in public service properties and securities was ushered in, and out of these exploitations vast fortunes were piled up with all the evils and low morals which usually attend the making of easy money.

These exploiters now, like Alexander, sighed for other worlds to conquer, and the cancer began to spread. To get what they wanted it was necessary to control " the powers that be," the powers that granted favors; and the same sordid sickening drama has been enacted all over the country. When you follow the trail of the corrupt politician to his usual place of business you will usually land in the directors' room of some corporation behind closed doors with the curtains pulled down. Wherever politics has been rotten, business has furnished the infection, and it has too often been transmitted by the man whose large power for evil was his cloak of eminent respectability.

I have heard men say business was cleaner than politics. I do not agree with that statement. In fact, they are one and the same thing. I don't know where or how there could be corrupt politics without a close business connection. If there were no corrupt business men to do the bribing and buying there would be no bribed and bought politicians. The grafter, Abe Ruef, in San Francisco, who is now doing time in San Quentin, was not a cause, he was simply the effect. The cause lay back of him, and it was a traversty on justice to send him to jail and allow the officials of the Southern Pacific Railroad and the United Railroad Company of San Francisco to go free, and it is that brand of so-called justice that is the cause of a large amount of the present unrest all over the country. Men have a feeling, and they have a right to it, that there are two laws in the land, one for the man who steals a dollar and another for the man who steals a million.

It was the special interests at Pittsburgh, Philadelphia,

Cincinnati, San Francisco, St. Louis, New York and some places nearer home, that were responsible for the bad local political conditions. The special interests were represented by the solid business men who furnished the money to do the bribing. They never did it themselves. Oh, no, they were too respectable to do more than furnish the money, but if some of these men of eminent respectability, but with dirty hands, had been compelled to wade through the filthy stream themselves, they might have sized up their rottenness. Such men are more to blame than the weak bribe-takers, who, for a mess of pottage, barter away the rights of the people. Special privilege sees to it that men are elected who can be serviceable. They are elected because they can be handled, and the people get just what they bargained for and what they deserve when they allow these conditions to exist, and they often exist because men like you fail to do your duty, in the rendering of service.

Worcester is a clean city politically, and if the great Apostle Paul were living in it, he could say with truth, " I am a citizen of no mean city." Yet in 1910, one of the aldermen told me — and he repeated on the floor of the Aldermanic Chamber — that a man who was connected with the Consolidated Railroad came to him and named three members of the Board of Aldermen who would be satisfactory to the Worcester Consolidated Street Railway Co. for president of the Board of Aldermen. Well, we saw to it that none of the three men who were so nominated or suggested were elected. There was no attempt at bribery; they simply wanted a man as president of the Board of Aldermen who would be friendly to their interests, and were not backward about making their wants known.

It is the same old story. From the beginning of time, private interests have always been vigilant, while public interest is allowed to remain anybody's, everybody's and consequently nobody's lookout. For example, in October, 1910, a hearing was held before the City Council of Boston on the petition of the Elevated Road to carry baggage and freight through the streets of Boston and for the erection of a large trolley freight terminal, and, if the press reports were correct, it was the most slimly attended hearing held in the city for years. According to the

Boston *Post* of October 15, 1910, " but six persons not directly interested appeared, and but one of these, Mr. James H. Brennan, of Charlestown, spoke in opposition to granting the franchise, he making the charge that a scheme to form a gigantic trolley express trust was behind the petition." Not another person in public life save the members of the Council were present, nor did a representative of any organization or association, with one exception, appear, to speak on the matter either for or against. The only person, beside the railroad representatives and Mr. Brennan, who addressed the Council was Mr. Joseph B. Eastman, secretary of the Public Franchise League, who has just been appointed by Governor Walsh as a member of the Public Service Commission, who said he thought his organization would approve granting the franchise with certain restrictions as to the time and methods of operating the proposed trolley express. That is a fair sample of the interest of the public in their own business, and under such conditions is it to be wondered at that the municipality gets the hot end of the poker handed out to it?

Often, after a bitter contest, a franchise is granted to a public service corporation, and, in a few years, the mayor, and every man in the Board of Aldermen and Common Council, and many of the heads of departments, having served their terms of office have stepped out and the new men in the City Council have no knowledge whatever of the conditions named in the franchises under which the corporations are operating. They have never seen them, have never heard of them, and have never given the matter even a passing thought. All the conditions have been forgotten, as the public service corporation expected they would be forgotten, and the corporation does as it pleases because there is no one with a knowledge of the facts and conditions continuously watching after the interests of the city. There is not a firm or corporation in existence that would be successful under such conditions.

The public service corporation sometimes rides rough shod over a community. I had one case of this character while mayor of my city. The decree of the court for the abolition of the Southern Railroad grade crossings in Worcester was passed before I became mayor, but the work had not been started. When this

matter was before the courts, as I understand it, the contention of the New Haven Railroad was that as Jackson Street was not to be touched there should be no land damage or consequential damages in connection with that crossing. But in working out the engineering details, following the lines laid down by the order of the court, it was found that to put in the foundations of the Southbridge Street bridge it would be necessary to take possession of a considerable portion of the Jackson Street location. Neither the engineers of the New Haven Railroad or the contracting engineers who were doing the work said a word to the mayor or city engineer, but they quietly laid their plans to take possession of the street, and accumulated on the railroad location adjacent to the work the proper machinery with supplies and material for putting in the concrete foundations, taking good care to make no move which would attract attention until after one o'clock Saturday, after all the courts had adjourned, so that there was little likelihood of an injunction should the city learn of their plan and try to stop it. About 10 P.M. on Sunday, I was asked by telephone if I knew what was being done at Jackson Street, and replied that I did not. I was then informed that the street had been fenced off and the foundation of the bridge, which took up about a third of the area of the street, was well along toward completion. I called the street commissioner and sent him down to see what was being done, and about midnight he reported as I have just stated. I then asked the city engineer, street commissioner, assistant city solicitor and chief of police to meet me at Jackson Street crossing at seven o'clock Monday morning, and about eight o'clock we located the contractor and I ordered him to stop work at once at Jackson Street and was informed by him that he did not take his orders from me; his orders were to put in the bridge; to which I replied, "You will take orders from me this morning." I then ordered the chief of police to arrest every man on the job for trespass if they did not stop work at once, and they stopped. I then had the street commissioner call in from different sections of the city about seventy-five men of his department and at 1 P.M. we moved on the works and tore down the concrete walls, threw the boards, etc., over on to the railroad location, destroyed the concrete foun-

dations which had been put in and which were hardening and said to the contractor, "It is your move." Inside the next forty-eight hours I had an agreement with the New Haven Road to buy for them the necessary land to take the place of the land taken in the street, and they would construct for the city as good a street as the one they had taken possession of.

For some time prior to my administration as mayor, the Consolidated Street Railway Co. had been trying to secure a franchise for carrying freight and express through the streets of Worcester. In 1907 the Board of Aldermen had granted such a franchise, and my immediate predecessor had vetoed the grant of the Aldermen because there was no time limit specified in the franchise, and this was one of the issues in the municipal campaign of 1907 when I first became a candidate for mayor. In my first inaugural message in January, 1908, I stated with considerable clearness my creed in regard to public service franchises, and after four years of experience as mayor, I would not now modify but would make stronger, if possible, the five articles in that creed. Permit me to restate them:

First, that the streets of the city belong to all the people of that city, and that no mayor or city government or state commission has a right to barter them away.

Second, that the day has forever passed when any city should grant a perpetual franchise of any kind whatever to any public service corporation.

Third, in granting a franchise for a term of years it should be the shortest possible term that would allow the corporation proper time for development, giving to it a fair return for its development and on the actual capital invested in the enterprise.

Fourth, that the time to attach conditions to a public service franchise is when it is granted, and that the city ought not to be forced to plead for that which is rightfully its own.

Fifth, that the mind of man cannot to-day frame a franchise naming conditions which will cover even the next ten years, to say nothing of protecting the far future, and for that reason perpetual franchise ought not to be granted, for nobody to-day can foresee what the future may have in store in the way of increased demands upon our public streets.

During the entire four years of my administration the subject of a trolley freight service was under consideration and, as I remember the circumstances, the trolley line had secured franchises on every trolley road up to the city limits, but the aldermen and mayor of Worcester, while desiring to grant the franchise with a reasonable time limit, had not been able to make any progress because the city, through them, insisted that there should be written into it a time limit (the suggestion being fifteen or twenty years), so that with the development of the next twenty years, if conditions were to arise which no man was wise enough now to foresee, there should then be a new deal based upon experience and upon the new conditions then existing.

The trolley company put up a plea of the enormous expenditures of money required to put the trolley freight service in operation, but when we began to investigate we did not find the occasion for enormous expenditures. The tracks, wires, poles and the complete organization were already provided, and all that was needed was a few cars and a freight depot. I said at one of the hearings at the State House that I could anticipate difficulties in the future for the trolley express company by *having* a time limit fixed, in the franchises, but I could also anticipate very serious difficulties for the municipality in *not* having a time limit fixed, and I trusted that while I approached the subject with an open mind I might be permitted to suggest that aldermen and mayors were elected to safeguard, as far as they were able, the interests of the city. The trolley companies did not need them to look out for their interests, for they had shown wonderful ability to take care of themselves.

When we had a hearing on this matter before the Massachusetts Railroad Commission, or before a legislative committee, I have forgotten which, and the attorney for the trolley road suggested that they did not know what kind of a mayor and board of aldermen the city of Worcester might have in twenty years, my reply was that the trolley road was evidently afraid to trust the future representatives of the city, but with the experience of the past twenty years fresh in our minds, it required some nerve to suggest that the city must surrender its rights to the trolley road and trust them entirely for all time.

While this contest was on I was reminded a good number of times that if I had aspirations for other political honors I was driving nails in my political coffin by carrying on this fight. Well, I had no other political aspirations, so I kept on the job. We were advised by the Railroad Commission that under the present law it would not have the right to approve a limited franchise, and my reply to that was, "Then let us have the law changed." Knowing the influence which put the law as it now is on the statute books we have got to put an end to public service corporations or any other corporations or special interests writing up the laws for their own control. There has been too much of that done already.

At a conference with the chairman of the Railroad Commission in October, 1909, when I was reminded by him that the Consolidated Street Railway Co. could go past the city to the Commission and get what it wanted without the consent of the Board of Aldermen, I said, "Well, I am glad there is still a Supreme Court to go to in Massachusetts." And the reply of the chairman was, "There is no way to get your case before the Supreme Court, Mr. Mayor; the Commission is in a sense the Supreme Court in this matter. The only way to get a change would be to change the law, and with the railroad interests so dominating at Boston, it is hardly possible to expect to get that done."

The Railroad Commission took the position that under the existing law they would have no legal right to grant a limited term franchise. The city solicitor submitted to the Railroad Commission a brief and asked the Commission to agree with the city on a statement of facts so that the City could bring the precise question at issue before the Supreme Court for a ruling; but the brief was practically filed and that was as far as it ever got.

A trolley freight franchise was granted by the Commission on December 4, 1911, without a time limit but with a proviso that should the Commonwealth in the future grant franchises with a time limit the city of Worcester had not lost its right in the premises, and that was all we saved out of a five-year fight, when I think every man in the Board of Aldermen and the mayor wanted to grant the right, but not in perpetuity.

Now, while we, as chosen representatives of the city, were waging that contest to maintain the natural rights of the citizens of Worcester that were yet to be, did Worcester come down to Boston as a unit? No, she almost never does. We presented a divided front as usual, and one faction for the privilege of selling a few more goods annually in Worcester County were willing to part company forever with God-given rights which were not theirs to give away. We can always be generous with what belongs to some one else. These rights belonged to the generations yet unborn, but the petty special interest of to-day was larger than the common good of the far extending future. Remember, the public service corporations are not the only special interests looking out for themselves.

It was my intention to tell you something about my long contest with the Worcester Electric Light Company but I found that in the preparation of the material for my paper to-night I had cut down more timber than I could trim out, so that I can only briefly refer to that contest which lasted from December 7, 1910, when I entered my complaint, to July 10, 1912, when the Gas and Electric Light Commission rendered its decision. It is a very interesting and instructive story and would be entitled to a whole evening; for it was an epoch-making contest, and I never could have made the fight had I not taken the bit in my teeth. If I had brought the matter to the attention of the City Council, the powers that be would have got busy with the members and I would have been checkmated. Let me explain what I mean.

I began my investigation in January, 1909, and in March I had gone far enough to be conscious of the fact that I needed expert knowledge which I did not possess, so I asked the city solicitor if I had the right to employ an expert without going to the City Council for authority to do so, and then I outlined to him my interpretation of the City Charter. I might add our charter was granted in 1893, and while, like all the works of man, it has its imperfections, it has been a good charter to work under. It says that when the City Council has appropriated funds for any of the departments of the city, such funds shall be expended by the head of the department under the direction of the mayor,

and that every contract in excess of three hundred dollars must have the approval of the mayor in writing. In like manner, when the City Council has appropriated funds to the general expense or incidental account, such funds are to be expended on the order of the mayor. I therefore asked the city solicitor the question, "To whom does the mayor go for approval of his expenditures from this account?" The city solicitor said my interpretation was right and I had a legal right to expend the money for expert assistance if I was willing to take the responsibility. As I was not going after this game with a brass band I didn't intend to ask for the authority of the City Council to do what I already had a legal right to do, and then find myself checkmated by the Electric Light Company, for were I to ask for the authority I knew the special interests, so to speak, would throw a monkey-wrench into the machine and put it out of commission. They would get busy the very next day with the members of the City Council and then we would hear the wail about wasting the "peepul's" money, and the powers that be would see to it that all the watch dogs of the treasury were on the job to save the city's money. That would be the claim, but the motive would be to prevent an investigation by not granting the sinews of war.

After I began my investigation and, in due time, it became known that I had an expert at work, there was newspaper opposition. It was stated that the mayor was spending money without leave or license, without any authority from the City Council, but I refused to discuss the matter through the press and kept right on the job.

Now for the vindication of that course. A little later in my administration we were having very poor service from the Consolidated Street Railway Co., and the president of the Board of Aldermen, who was chairman of the Street Committee, introduced an order to employ an engineer to examine and report to the City Council in regard to the equipment, power plant, etc., of the Consolidated Street Railway Co. The chairman of the Board of Aldermen brought to me the order before it was introduced, and I told him I could pay for that investigation out of the incidental account, which could be expended on the order

of the mayor if I so desired, but I said, " You go ahead and this will vindicate my position in not asking the City Council for authority to hire an expert in the Electric Light investigation." His original order called for an appropriation of one thousand dollars, which he finally offered to reduce to five hundred dollars in hopes to get it through, although that would not have been sufficient to pay for any investigation worthy of the name. Did he get the amount asked for? Not one red cent. The powers that be got busy and the representatives of the people, the watch dogs of the city treasury, howled about throwing away the " peepul's " money, and two of the aldermen whom I referred to earlier in this paper, who were satisfactory to the Consolidated Street Railway Co. for president of the Board of Aldermen, voted against the order to appropriate the money, and there the matter practically died and there was no investigation worthy of the name; but that abundantly vindicated my course in not asking the City Council for authority to do what I already had a legal right to do.

The foundation of our government is assailed by two forces which are at the opposite extremes of our political life. Many of the people see only the danger from the low-down grafter, who would, through the cheap politician, by corruption and through the aid of the saloon, control the political destinies of town, city, state and nation. But there are other enemies which have been doing their work against the interests of the public. These men are not of the low-down grafter order, but quite the reverse. They are clear at the other extreme, the high-toned, so-called solid business men who have for years been exploiting the public for their own private gain, and in large measure they are the men who are creating the unrest at the present time. Now, what is the cure for part of our troubles? An awakening of civic righteousness, an aspiration for better civic conditions, a larger sense of duty and personal responsibility by just such men as are here to-night, a willingness to render service. We have in the last few years been passing through an industrial and commercial revolution, and the air is somewhat clearer. Much of the underbrush of pernicious business practices has been cut away. The lines between honesty and dishonesty have been resurveyed; new

bounds have been set, and many men are viewing duty from a new angle of vision.

And what is the duty of those who are in control of our public service corporations? I do not like to sit in judgment on other men, but we are sometimes compelled to, but the longer I have been a student of municipal conditions the more it has seemed to me that a type of mind has been developed by the management of some public utilities which cannot, or at least does not, get a correct perspective of the duty which it owes the community. It is like what we are seeing exhibited in Germany to-day, — an utter inability to see the cold logic of facts except from a perverted angle of vision. The men in control of many of our public utilities have shown themselves to have been inspired by the spirit of supreme selfishness and that alone. One thought has been uppermost in their minds, and that has been to exploit the public for their own benefit. Now, if ever, is the time for them to consider diligently the public good and if for none other than the most selfish reasons, that lasting security may be given to their private interests. If they do not do this, if they do not change their policies and work more for the common good, there will be a day of reckoning for them.

There must be more publicity — there must be less done behind closed doors, and the accounts of these corporations must be kept so as to disclose rather than hide the actual conditions. Why do I make this so strong? Because it took months of work to get out of our Worcester Electric Light Company the information in regard to its condition that the mayor demanded in his contest with the company — information that he, as the chief executive of the city, had a right to know. From first to last there was a studied attempt on the part of the company to prevent the facts from being made known,— and why? Because they knew that they were overcharging the city and the citizens by excessive rates and putting the extra amounts so taken from the public into their plant, so that when the Gas and Electric Light Commission rendered its decision it gave the mayor everything he contended for.

The mayor protested against their taking from the citizens of Worcester over one hundred thousand dollars a year through

a depreciation account that represented their method of bookkeeping to hide their profits, and the Commission, in rendering its decision said, " When the company first made a return to this Board, in 1888, it had a plant valued at $109 000 and a capital stock of $100 000. Its returns since then show that of the amounts expended on its plant, nearly one half has been provided out of earnings on account of depreciation charges and in the accumulation of an actual surplus; all this in addition to ample maintenance charges and its operating accounts." In other words, the Commission said that the City of Worcester and the citizens of Worcester had out of their own pockets paid for nearly one half of the plant, and in my opinion, the people of Worcester have paid for more than half of it, and yet they have not a dollar of interest in it.

They may come back and say they have never had any dividends on the surplus, but they don't deserve any credit on that score. In 1908 and 1909 the gas and electric light companies of the state had bills before the legislature asking for permission to capitalize their surplus so they could get dividends on it, although the headings on the bills presented to the legislature did not put it that way.

The mayor said they must be compelled to render service and give the public lower rates, and that they have done. He asked for a reduction in the price of street arc lights, of which there were about 900, from $91.25 to $80.00 per annum. The company wanted $96.28. The Commission gave the city $80.30 to make even money, 22 cents per lamp per night. The mayor said in his testimony that in three years the company would thank him for what he had done, and what has been the result? In 1909 the company did a business of $347 543.83, and notwithstanding the reductions in rates that have been made since then, their business for the year ending June 30, 1914, aggregated $880 248.19, and they made $76 265.04 more profit in 1914 than their total income in 1909, and they haven't come round with an honorarium of even a nickel to the now ex-mayor for helping to put them on their job. But there are compensations. I don't think there is a man connected with the company who is not my friend to-day, and he ought to be, for I was the best meal ticket they ever struck.

I cannot close this talk to-night without making acknowledgment and expressing my thanks, giving great credit to the attorney who fought this battle for the mayor and the city of Worcester. The city solicitor was ill and away from the city, and my friend, Webster Thayer, Esq., came to my assistance and put up the fight of his life, and without his splendid help the result might have been very different.

And now in closing permit me to say the public service corporations are the servants of the people and not their masters, and the master is entitled to an account of the servant's stewardship. The public service corporation must move out of the valley of seclusion, where it has too long transacted its business. Its new offices must be on the hills of publicity, in full view of the people, whose servant it is, and it will then be treated to a great surprise, for it will be found that it will cost less to do its business out in the open than it has cost it in the past to do it in back offices with the curtains drawn down. In that good old Book, now much neglected, but in which is stored the wisdom of ages, and to which even in these days of commercialism we can turn in hours of trial, sorrow, disappointment, and when burdened with heavy cares and responsibilities in bearing our twentieth-century burdens, and find in it the courage, the inspiration and the help that will hold us true to the course, we find expression to a fundamental truth when it says, — "And the truth shall make you free." And so it will be with the public service corporation when the light of publicity has been let in on their doings. When they have nothing to hide they can take the public into their confidence, "and the truth shall make them free."

DISCUSSION.

By Messrs. Alonzo R. Weed and Frederick J. Macleod.

Mr. Weed. — *Mr. President and Gentlemen,* — I told the President, a little while ago, that I came here to listen to Mayor Logan and not to make a speech. But one of my neighbors, who is in the habit of making after-dinner speeches, sometimes says that he is like a dog and speaks for his dinner. I suppose

that perhaps I, likewise, owe to the President a speech for my dinner.

There were one or two things which Mayor Logan said — and I can assure you that I have seen him in action with his war paint on, his tomahawk in one hand and his rifle in the other, and I know he has done some very admirable service for his city — which I think are worth while emphasizing. If I speak in a very inconsequential way about them, I am sure you will pardon me for that.

I think he brought out one thing which very likely has impressed many of you gentlemen who have been before any public service bodies, the legislature or any committees or any other public boards, or even the municipal boards. And that is, that there is usually a very great inequality in the contests that go on before those boards. The men of training and brains and character are arrayed on one side, and there is a pretty raw product arrayed on the other, and the contest is not equal. I think this fact necessarily arouses in the minds of those who have to listen to that sort of a contest a good deal of sympathy for the public. The public is so often so extremely poorly represented. The case to which the mayor has alluded, which occurred in relation to the Worcester Electric Light Company, is one of the few cases which my Board has heard, since I have been a member of it, where the public really had an adequate representation, where you felt that in a way the two sides were on a fair equality in the character of the presentation of their respective cases, the evidence submitted, and the scope of the inquiry. Such a presentation is extremely helpful to any one who must for the time being try to hold the scales of justice.

There was one other thing to which he alluded which I do not believe has as much emphasis given it as should be given, and that is the question of complete publicity of the affairs of those corporations which have to do with the public service. The longer that I have dealt with questions of that sort the more I am convinced that this is the one feature of what we term public regulation which has a very substantial promise in it. I am inclined to think — and I am speaking, perhaps, rather frankly about it — that there are many other features that have not

much promise. We are temporizing, we are dealing in ways that cannot perhaps be more than temporizing, in many other important features of those relations. But publicity is a thing which speaks for itself and is a thing which we never yet have attained. I am confident, personally, that, if we had a publicity which was not only complete in itself but which commanded confidence so that people thought that they were getting the truth, many of our troubles would solve themselves. I think that we oftentimes get a great deal more truth, that the facts are really revealed, far more than the public gives credit for their being revealed. But there has been a sufficient amount of the reticence to which allusion has been made, there has been a sufficient amount of evasion, of covering up, of trickery at times, to have excited a very great distrust in anything like a claim of frankness on the part of the public service corporations. And it works extremely unfavorably, and to the very great disadvantage of such of the men in charge of those corporations who are entirely willing to have the truth known, men of high character, who may differ with the public with respect to certain policies, but have no disposition at all to have any question raised about facts. A fact is a fact; it is changeless. If we can only know that fact, there is no longer any chance for dispute about it. The only question which then remains is as to what theory we shall have with respect to a known thing. We may well differ over theories and policies, but a fact should be known once for all. We need a publicity in which people have confidence and have reason to have confidence. When we have that, I am confident that very many disputes which become exceedingly acute at times will never occur at all.

There is something else which I would like to say, because I may not get a chance to talk to engineers *en masse* again. I see them individually a great many times, and I have come to have a very profound respect for the profession of engineering. I cannot conceive of anything really finer in the way of human achievement than to have the capacity to imagine some great undertaking, to see it in all its details, to see that the work is properly assembled and constructed and to see something actually grow under one's own hand and in consequence of one's

own conception. This seems to me one of the finest bits of human achievement and human service that can be performed. I hope I have said that as earnestly and as emphatically as I feel. But I cannot but believe that there is a great deal of extremely valuable engineering ability which to my mind has been diverted from the fine things to which it might be applied in the attempt to determine a lot of things which are not worth determining after they are all found out, or apparently found out. I am speaking now of the great diversion of engineering ability to the effort of solving a great many of these so-called public service problems. We have in this country, for a variety of reasons, come to have a large literature, and a wide discussion through technical journals and from engineers on what is called the reproductive value of property. But it is a speculation, as we all must realize, and relates to something which never will happen, and which is never expected to happen; and after you have speculated and reached such agreement as wide differences of opinion, due to varying unit costs and to the elements of value to be considered, makes possible, the conclusion really settles nothing permanently.

For my own part, I think that that is a great waste of a finely equipped body of human energy, and it seems to me that it is a diversion, a very great diversion, from the great work of which it is capable. I think it has come about, to some extent, through a misconception of the whole policy and theory of public regulation, of its philosophy, if I may speak of it as such. It is true that the only reason we try to regulate at all is because we are trying to enlist private capital in certain services which the public manifestly might perform for itself if that seemed the more expedient way. And we have created to a very considerable extent with regard to them exclusive privileges for their performance, for a variety of reasons which it is hardly necessary to discuss here.

I have never supposed that a monopoly in a public undertaking was essentially different from a monopoly in a private undertaking. And I have supposed, and I think there is reason to believe, that the inducement to monopoly is that profits by reason of monopoly can be increased over what is probable in a

state of competition, or they can be made surer by means of monopoly. And I suppose when we are trying to settle the questions of public regulation, we are in reality trying to enlist self interest, private capital, having all the desires and impulses that private capital has in any unregulated business, and trying to curb its very natural desire for an excessive profit, or a profit beyond the profit which it might get without the monopoly, or the sure and safe profit and therefore usually the stagnant service which might also result from the control of the supply.

That is what we are trying to curb, and perhaps it may be done by the application of some of those universal and mathematical rules which have been laid down from time to time. On the other hand, so far as I have seen corporations, they differ just about as much as individuals. They reflect, just as individuals reflect, the motives, desires, dreams, ambitions, failures, successes of the men who dominate them from time to time. We cannot cast them all in the same mold because they cannot in the nature of things be cast in the same mold, and we have to deal with them as best we may. But what we are really trying to control and to keep within reasonable bounds is this very natural desire with respect to profits which must always exist, so far as we can see, so long as we have private ownership at all.

I was rather interested the other day. A man came in — and he happened to be a lawyer — to talk with me about a matter of rates, and he expressed an idea that I had never heard expressed in the same way, in saying that any public interference with rates was confiscation. We have discussed, until the air is blue with discussion, how far we can go in such interference without confiscating. But he said any interference is confiscation, just as any taxation, to the extent to which it goes, is confiscation. I am not sure but that he may be right, and that we are only saying to what degree it may go; trying to find some practical measure for it. I do not believe personally that the problem is strictly an engineering question, although the technical knowledge, the engineer's point of view, the engineer's knowledge, offer information on many factors which are extremely important.

What I sincerely hope, as I said before, is that the tremendous service which engineers do perform, and can perform, may not be diverted from their real work to what seems to me to be rather a side issue.

MR. MACLEOD. — *Mr. Chairman and Gentlemen,* — I felt rather put at my ease when Mr. Weed stated that he had come here this evening with the expectation that he would not be called upon for an address. I thought that he would content himself with making a few formal remarks, and that I could deal with the subject in the same summary way and save my face. But after the elaborate and interesting address that we have just heard from Mr. Weed, I suspect that he must have been turning over some of these things in his mind before he came here this evening.

As far as I am concerned, I can also say with entire frankness that I had no idea that I was going to be called upon to speak. Perhaps it is just as well that I received no such intimation in advance, as otherwise I should not have had such a good time this evening, or, indeed, I might not have been here at all.

The Commission of which I have the honor — or perhaps after listening to Mr. Logan's address I should say the notoriety — of being a member, has, during the last few weeks especially, had a rather strenuous time. We have had the ordinary routine matters which come in the normal course of the Commission's work, and in addition we have had a large number of matters of capital importance thrust upon us with alarming confusion and alarming frequency by the legislature. We are expected, by drawing upon some hidden reservoir of wisdom, to present in a report which has been incubated over night, a final solution of some of the most complex problems in the whole field of public service regulation. Consequently I have been obliged, owing to the tremendous pressure of official business during the last two or three weeks, not only to work during the normal time of an ordinary business day, but also to disregard the eight-hour law by remaining at the office till nearly midnight, and even to use the Sabbath day in the same ungodly fashion. I trust that I may be pardoned, therefore, if just at this time I do not feel any particular enthusiasm for talking shop.

I should like to say, however, that I do not know of any address that I could have heard this evening on a subject of this kind which would have been as little fatiguing as the address to which we have just listened. The whole matter was presented with so much spirit, and with so many humorous touches and interesting thrusts and parries, that it was an intellectual delight, and I know of nothing that could have afforded me as much mental stimulus and refreshment this evening as Mayor Logan's address.

The mayor, from his experience in dealing with public service problems in his own city, has called attention to certain facts, and has expressed certain views, that are well worthy of the attention of an audience of this kind, or indeed of any kind of an audience. His address may not have given the entire story, but it presented one side of the shield. In so far as it may not represent, perhaps, the whole truth in regard to some of these problems, I do not conceive that it is any part of my function as chairman of a commission representing the public to try to present anything on the other side of the case. I quite agree with Mr. Logan that the public service companies are abundantly able to present their side of the case on all occasions.

I was struck, just as was Mr. Weed, with that part of Mr. Logan's address which pictured, I think very vividly, the conditions which are apt to attend hearings before legislative committees and commissions upon matters affecting public service corporations. These conditions are well illustrated in an important case which the Public Service Commission has recently had under consideration. In that case the Commission in joint conference with the commissions of other states was attempting to formulate a program for uniformity of law and policy in railroad regulation within the several states exercising concurrent jurisdiction over interstate railroad corporations. The Commission gave public hearings on this matter and expected to receive many valuable suggestions from representatives of the public in regard to proper measures for safeguarding the public interest in a matter of such vital importance to the people of this Commonwealth. But when the case was called, and during the progress of the hearings, there were only eight or ten men

in the hearing room. They were an intellectual group of men of extremely fine personal appearance, and they all represented the corporations.

The fact that in so many cases the public side of a pending issue is either not presented at all, or presented only in a feeble manner, adds a large additional burden to the work of regulating commissions, as the functions and duties of the commissions are in many ways so much broader than those of the courts. The courts are obliged in the main to try the case on the record of the evidence presented by the parties. If a litigant fails to bring out some pertinent part of his case, or to introduce certain necessary evidence, the decision goes against him, as the court is not expected to make any independent investigation of the facts. But not only is the duty thrown upon the Commission of considering the evidence presented by the parties at the hearing, but it is also obliged to supplement the facts presented at the hearing with all the facts it is able to discover through its own investigations.

I believe, however, that most of the members of our public commissions do recognize and do make allowances at every stage of the proceedings for the fact that the representatives of the public service corporations are apt to be more experienced, more able and more adroit than those who represent the public. In reaching its conclusions on any case the Commission should make, and does make, allowances to represent the bias which comes from that interested point of view. If you have a commission with knowledge and experience in regard to matters within its jurisdiction, it is in the last analysis a pretty difficult matter for any lawyer or advocate, no matter how clever he may be, to disguise or to befog the real issue.

The possibility of this is apt, I believe, to be greater, especially in abstruse or complex matters, where hearings are given by legislative committees, or by boards of aldermen or other local boards. This is by no means due to the fact that they have any less zealous regard for the public interest; indeed, as they are the direct representatives of the people, we might assume that their regard for the public welfare is greater than that of appointive commissions who represent the public one degree

removed. But it is easy for men who are holding an ephemeral position for a year or two in the legislature or the board of aldermen, and who are obliged to deal with many matters of which they have no expert knowledge or personal experience, to be misled by the subtleties ot special pleading which often have just enough basis of truth to be well calculated to impress and perhaps to deceive those who have merely a general knowledge of the subject under discussion.

So far as local problems of the city of Worcester are concerned, I might say that the first legacy that I received from my predecessors when I became a member of the board of railroad commissioners in August, 1911, was the question of granting a limited-term trolley freight franchise to the street railway company operating in the city of Worcester. At that time the hearings on this case were all over, the evidence was all in, and the matter had practically been concluded, although, as I recall it, the duty fell upon me of drafting the order to which the mayor has referred.

In this connection I might add that the Commission is often blamed, and perhaps blamed justly, for its lack of wisdom or its lack of public spirit in some matters; but it is also often blamed for things for which it is not justly to be held responsible, as the Commission is obliged to act in conformity with existing laws, and to administer these laws as they stand. We have nothing to do with the creation of those laws, and if they are alleged to be bad in any case it is due to conditions beyond our control. The matter to which Mayor Logan referred is a case in point.

The city of Worcester asked the Commission to grant the Worcester Consolidated Street Railway Company a trolley freight franchise in the city of Worcester limited to a term of years, but as the Commission viewed it, it had absolutely no discretion to grant any such request. The Commission is, under the law, directed to act under the advice of the attorney-general, who is the law officer of the Commission and its adviser. The Commission was advised by the attorney-general that it was beyond the power of the Commission to approve a limited term franchise. The Commission therefore had no discretion except to approve the franchise with such conditions and limita-

tions only as were authorized by law. I might add also that the rights of the city were amply safeguarded, as the order was drawn advisedly in such a way that the legal issues presented by the city can be raised at any time in the courts. If therefore the city believes that the Commission or its adviser, the attorney-general, was in error in regard to the law, the city has full opportunity to test that matter in the highest legal tribunal of the state.

There are a number of things suggested by the discourse of the evening that I might like to say, but lest I be accused of attempting to make a speech, I will refer briefly to one matter only. In public service regulation, as in most other matters, I believe in the largest practicable degree of home rule. Where the action of the local authorities is subject to review by the Public Service Commission, the Commission is very slow to interfere with any reasonable exercise by local boards of the authority vested in them in regard to grants of franchises to public service companies, or in regard to other matters within their jurisdiction. Indeed, in so far as public service corporations are purely of local character, it might be advantageous to broaden the present scope of municipal regulation.

I attended a conference in Philadelphia, two or three months ago, of the mayors of different cities and representatives of different state commissions, in regard to the regulation of municipal utilities. This conference proved to be one of the most interesting that I ever attended, because it gave a viewpoint on certain matters distinctly different from the general viewpoint in this state. The dominant sentiment of that conference, representing, I believe, all the large cities and a great many of the more important cities of lesser size, was in favor of the extension of municipal regulation, even at the expense of state regulation.

Personally, I believe that in a great many matters where the municipality is in a position to deal directly with the company involved, it can often get results, and get them more directly, than they can be obtained through elaborate and extended investigations through commission regulation. On the other hand, there are difficulties in the way of local regulation over

corporations that are not purely local in character. Of course the railroads not only serve different cities, but different states as well, so that municipal regulation of railroad companies is practically out of the question. The same is true to a large extent of street railway companies. For instance, the street railway company that serves the city of Worcester serves a large number of other cities and towns in the Commonwealth. If each municipality attempted to deal independently with that company it would be subjected to many different and possibly conflicting requirements which would be likely to produce a condition of chaos. At the same time I am distinctly in sympathy with the extension of regulating power by the municipal authorities whereever it is reasonable and practicable. This would afford a wholesome and additional check on some of the abuses of public service companies that we have been hearing about to-night.

From such investigation as I have been able to make of existing conditions, I am convinced that the troubles of the railroads and other public service companies have been due, not to too much regulation, as some of the officials of the companies would try to have you believe, but to too little regulation. The difficulties that have been confronting these corporations have been due to the fact that they have indulged in practices that have been unwise, imprudent, or worse, and have done so either because of lack ot adequate powers of public service regulation, or because such powers have been inefficiently exercised. I therefore welcome anything that represents a strengthening of the forces of the public in dealing with the public service corporations that serve the municipalities and the state alike. The example of the mayor of a great city, such as Mayor Logan, who has fought so zealously for the protection of public rights, is one that is worthy of emulation throughout the Commonwealth.

MEMOIRS OF DECEASED MEMBERS.

ROBERT LELAND READ.*

Mr. Read was born in Manchester, N. H., on July 12, 1841, and he died in Portland, Me., on June 9, 1912. His ancestors were distinguished in the early history of the country and in consequence he became a member of the Society of Colonial Wars and several other prominent organizations interested in the colonial and revolutionary periods. After his retirement from the active duties of his profession, he was frequently present at their meetings in Boston and was always actively sympathetic in their proceedings.

Mr. Read was educated at Dartmouth College, and was one of the early graduates of the Chandler Scientific School. In 1864 there were seven graduates, Mr. Read being the only one of that number who entered the profession of civil engineering.

Soon after leaving his studies, Mr. Read, in January, 1865, was fortunate in securing a position as assistant engineer on some surveys connected with the Indianapolis, Cincinnati & Lafayette Railroad, and he remained with this road for several years. The war was just ending and the railroads were passing through a trying period, with little money available either for maintenance or construction; it is therefore rather surprising to find that the compensation given Mr. Read was $100 per month and all expenses paid. A short time afterwards we find, from Mr. Read's notes, that the regular pay for an instrument man was $130 per month and expenses. The panic of 1873, however, caused these prices to drop suddenly and permanently.

The early railroad experiences of Mr. Read follow closely the experiences of the writer of this sketch in southern Indiana at the same period, and are so characteristic of local conditions

* Memoir prepared by Desmond FitzGerald.

at that day that he has ventured to rehearse some of Mr. Read's notes and later to quote several lines in full.

A majority of the railroad officials prided themselves on being practical men, with no scientific training. They looked on an engineer as a necessary evil in construction, and one to be quickly discharged as soon as the roadbed was finished. The master mechanics were generally promoted from the ranks of locomotive engineers and, as a rule, had but a poor opinion of book-learning. The master mechanic of Mr. Read's road once said to him, " I never bother myself with what other master mechanics are doing, except to make my engines different from theirs, so the president and superintendent of our road will think they have a smarter man than the other roads have."

Under this system, when the " Big Four " roads were consolidated, out of five hundred locomotives, there were 115 different types. They were small wood-burners and capable of drawing only from three to four cars.

Soon after Mr. Read began his railroad work, he was sent to make surveys of a branch line from Fairland to Martinsville. In regard to this branch, Mr. Read writes: " . . . the first twelve miles being new line and the last twenty-six the rebuilding of an old road that had been originally laid with strap rail and abandoned many years previously when the track became so bad that a man had always to walk ahead of every train with spikes and maul to fasten down the loose rails.

" The resident engineer ran the transit and I the level. Just before the location was finished, the resident engineer went on a spree, and I never saw him on the work afterwards. The chief engineer, who only spent a few hours on the work during the whole period of construction, placed me in charge, but would give me no assistant, so I had to do all the instrument work, inspection and office work; this meant at least sixteen hours a day. Our party was not allowed a horse, so we had to walk the thirty-eight miles between the ends of the work, living on the country, with all that meant in southern Indiana, which was principally settled by poor whites from Kentucky."

Following these early experiences, Mr. Read became chief engineer of several railroads connected with the " Big Four "

system. From October, 1870, to May, 1871, he was engaged as contractor on the construction of twenty-nine bridges on the Atchison Road, after which he was connected with the Ohio & Mississippi Railroad, the construction of the Storrs incline at Cincinnati, and later became chief engineer of the Indianapolis Belt Railway; in the latter capacity he was associated with General Harrison, the attorney for the enterprise, who later became President of the United States.

In 1874 Mr. Read became a member of the American Society of Civil Engineers, and later a director. He was at one time president of the Engineer Club of Cincinnati and was associated with other engineering societies.

Mr. Read married Miss Abby H. Eastman, of York, Me., on September 2, 1869. She was a daughter of Dr. Caleb Eastman and Adeline Talpry, and she died August 30, 1893.

When Mr. Read retired, he removed to Malden, and in the summer was a prominent resident of Biddeford Pool, Me., where he was active in good works of every kind. In his will was a bequest of one thousand dollars to Dartmouth College, "the income of which is to be used as an annual prize for the best work in descriptive geometry."

The above are the hard and fast outlines of a busy life; but they poorly portray the real man, whose kindness and charm of manner endeared him to all with whom he came in contact. The latter part of his life, after the struggles and heat of the day had passed, must have been in many ways a very lonely one, but he was never heard to complain, and maintained a calm and cheerful spirit to the end.

Vol. II SEPTEMBER, 1915 No. 7.

BOSTON SOCIETY OF CIVIL ENGINEERS
FOUNDED 1848

PROCEEDINGS

NOTICE OF REGULAR MEETING.

A REGULAR meeting of the Boston Society of Civil Engineers will be held on

WEDNESDAY, SEPTEMBER 15, 1915,

at 7.45 o'clock P.M., in CHIPMAN HALL, TREMONT TEMPLE, BOSTON.

Mr. M. J. Lorente, C.E., will read a paper entitled, "Some Special Methods of Reinforced Concrete Design." The paper is printed in this issue of the JOURNAL.

S. E. TINKHAM, *Secretary*.

PAPERS IN THIS NUMBER.

"Special Methods of Reinforced Concrete Design," M. J. Lorente. (To be presented September 15, 1915.)

Discussion of "Ground Water Supplies."

Contributors are hereby notified that proof will not be submitted to them for examination unless requested before the 10th of the month preceding the month of publication.

MINUTES OF MEETINGS.

Boston, Mass., June 16, 1915.—A regular meeting of the Boston Society of Civil Engineers was held this evening at Chipman Hall, Tremont Temple, and was called to order by the President, Charles R. Gow, at 8 o'clock. There were 63 members and visitors present.

By vote the reading of the record of the last meeting was waived, and the record as printed in the June Journal was approved.

The Secretary reported for the Board of Government that it had elected the following to membership in the grades named:

Honorary member—Past President Desmond FitzGerald.

Members—Messrs. Gale Augustus Carter, John H. Coghlan, Elias Francis De La Haye, Jr., Harry C. Foster, Joseph Francis Aloysius Leonard and Charles Frederick Parker.

Associate—Mr. George Woodward Langdon, Jr.

Juniors—Messrs. Harry Leon Katz and Max Silverman.

The Secretary announced the deaths of Theodore L. Keppler, an associate of the Society, who died May 24, 1915, and Lorenzo G. Moulton, a member, who died June 9, 1915. By vote the President was requested to appoint committees to prepare memoirs. The President has appointed committees as follows: On memoir of Mr. Keppler, Mr. Frederic I. Winslow; on memoir of Mr. Moulton, Mr. L. Lee Street.

The Librarian called attention to the rules now in force in relation to the circulation of books in the Society's library. These rules were adopted in 1896, and because of changed conditions in the library they are not now entirely satisfactory. On motion of Mr. Sherman, the Committee on the Library were empowered to make such rules in relation to the circulation of books in the library as they deemed advisable.

On motion of Mr. Wason, the thanks of the Society were voted to Mr. George A. Dodge for the admirable way in which he served the members of the Society and those of the New England Water Works Association on the occasion of the joint outing at Pemberton Inn on June 16, 1915.

The President then introduced Prof. Charles F. Binns, director of the New York State School of Clay Working and

Ceramics at Alfred University, Alfred, N. Y., who delivered a most entertaining and instructive address on "The Application of Clay Products to Some Engineering Problems." Among other topics taken up were, varieties of clay, preparation of clays, manufacture and testing of structural wares, terra-cotta, hollow tiles, paving bricks and the construction of brick pavements. The address was fully illustrated with lantern slides. At the close of the address, the thanks of the Society were extended to Professor Binns.

Vice-President Richard A. Hale presided during the latter portion of the meeting.

Adjourned.

S. E. Tinkham, *Secretary.*

APPLICATIONS FOR MEMBERSHIP.

[September 3, 1915.]

The By-Laws provide that the Board of Government shall consider applications for membership with reference to the eligibility of each candidate for admission and shall determine the proper grade of membership to which he is entitled.

The Board must depend largely upon the members of the Society for the information which will enable it to arrive at a just conclusion. Every member is therefore urged to communicate promptly any facts in relation to the personal character or professional reputation and experience of the candidates which will assist the Board in its consideration. Communications relating to applicants are considered by the Board as strictly confidential.

The fact that applicants give the names of certain members as reference does not necessarily mean that such members endorse the candidate.

The Board of Government will not consider applications until the expiration of twenty (20) days from the date given.

Alexander, Clayton Clifford, Medford, Mass. (Age 33, b. Killingly, Conn.) Student for three years at Univ. of Vermont, and for one year at Univ. of Maine, civil engineering course. From 1902 to 1903, instructor

in civil engineering, Univ. of Maine; from 1903 to 1905, designing draftsman with General Electric Co., Schenectady, N. Y.; from 1905 to 1908, in charge of party on Panama Canal with Isthmian Canal Comm.; from 1908 to 1910, with Cheney Bigelow Wire Works, Springfield, Mass., in charge of drafting; from 1911 to 1913, with Providence Steel and Iron Co., estimating and designing on roofs and bridges; during summer and fall of 1914, inspector of Springfield underpasses with S. H. Pitcher Engineering Co; is now second assistant city engineer, Woonsocket, R. I. Refers to F. A. Caldwell, C. F. Parker, L. K. Rourke and Arnold Seagrave.

Allardice, James Proctor, Fall River, Mass. (Age 24, b. Fall River, Mass.) Graduate of Worcester Polytechnic Inst., 1915, civil engineering course. During summer vacation, 1913, rodman and instrumentman; from June, 1914, to March, 1915, instrumentman and chief of party with E. M. Corkett, C.E., Fall River; from March, 1915, to date, force accountant on Fall River Intercepting Drain with Barrows & Breed, Boston. Refers to V. J. Gallene, H. C. Ives, A. J. Knight, H. L. Robinson, G. S. Sawyer and A. L. Shaw.

Barney, Harold Bryant, Chestnut Hill, Mass. Age 29, b. Roxbury, Mass.) Graduate of Harvard, 1908, degree of A.B.; received degree of S.B. in civil engineering from Lawrence Scientific School, 1909. From 1909 to Dec., 1913, draftsman, inspector, division engineer, etc., with Stone & Webster Engrg. Corp'n at Seattle, Wash., and in California; from June, 1914, to date, with Warren Bros. Co., of Boston, as timekeeper, etc. Refers to H. K. Alden, L. E. Baker, L. J. Johnson and C. E. Nichols.

Bennett, Raymond Franklin, Portland, Me. (Age 39, b. Freeport, Me.) Graduate of Mass. Inst. of Technology, 1899, civil engineering course. From 1892 to 1899, worked during summers with various surveying parties; for nine months during the year 1900, draftsman with Bridge Dept., N. Y., N. H. & H. R. R.; since Nov., 1900, member of firm of W. F. Bennett & Son, contractors for pile driving, wharf building, etc. Refers to P. A. Babcock, Richard Brunel, L. F. Ellis and E. E. Pettee.

Colby, Edwin Whitmore, Boston, Mass. (Age 24, b. Medford, Mass.) Student in structural engineering for four years at Franklin Union. From June, 1908, to Aug., 1910, with Whitman & Howard, as rodman, instrumentman and draftsman; from Aug., 1910, to March, 1912, inspector with Edison Electric Ill. Co., on underground conduit construction; from March, 1912, to March, 1915, with Whitman & Howard, as assistant engineer on street railway surveys and construction, highway surveys, topographical surveys, etc.; from March, 1915, to date, with Metropolitan Water Works, as assistant engineer. Refers to Randolph Bainbridge, Benjamin Boas, W. E. Foss, Channing Howard, E. H. Rockwell, R. C. Smith and F. A. Snow.

Howard, David Russell, Woonsocket, R. I. (Age 29, b. Fall River, Mass.) Received education in public schools. From March, 1904, to Jan., 1911, with E. K. Watson Co., building contractors, Warren, R. I., first as timekeeper and later as assistant to engineer; in Jan., 1911, incorporated

the Eastern Construction Co., Woonsocket, R. I., and became one of its directors; since that time has acted as president, treasurer and general manager of that company. Refers to F. A. Caldwell, F. H. Mills, C. F. Parker and Arnold Seagrave.

MAKEPEACE, BERTRAND L., Brookline, Mass. (Age 43, b. Foxboro, Mass.) From 1895 to date has been engaged in manufacture of blue prints and black-line prints for engineers, architects, etc., during which time has added to this line drawing materials and surveying instruments; in 1911 equipped machine shop for manufacturing, overhauling, repairing and rebuilding surveying instruments; is specialist in engineers' goods and scientific instruments. Refers to E. M. Blake, Channing Howard, J. J. Van Valkenburgh and W. F. Williams.

WALKER, FRANK BATES, Winthrop, Mass. (Age 41, b. Traverse City, Mich.) Graduate of Univ. of Minnesota, 1897, degree of C.E.; student in mining engineering, 1899 and 1900, at Mass. Inst. of Technology. Later held subordinate positions in Engineering Depts. of M. & St. L. R. R. and M., St. P. & S. S. M. R. R.; from 1897 to 1898, assistant engineer and chemist on blast-furnace work for Cleveland Cliffs Iron Co.; for fifteen years, assistant and resident engineer on Great Northern R. R.; since spring of 1914, assistant engineer in charge of bridge work, etc., for Bay State Street Ry. Refers to H. W. Hayes, A. W. Hodges, L. E. Moore and J. R. Worcester.

LIST OF MEMBERS.

ADDITIONS.

BURROUGHS, RUSSELL .... Concord, N. H.
CARTER, GALE A. .... Box 183, Colebrook, N. H.
COGHLAN, JOHN H. .... Lowell St., Lexington, Mass.
DE LA HAYE, ELIAS F., Jr. .... 38 Intervale St., Roxbury, Mass.
FARWELL, JOSEPH W. .... 1803 Washington St., Canton, Mass.
FOSTER, HARRY C. .... Western Ave., Gloucester, Mass.
HARTY, JOHN J., Jr. .... 310 Technology Chambers, Boston, Mass.
KATZ, HARRY L. .... 100 Granville Ave., Malden, Mass.
LEONARD, JOSEPH F. A. .... 4011 No. Main St., Fall River, Mass.
O'NEIL, THOMAS P. .... 10 Fairfield St., Cambridge, Mass.
PARKE, ROBERT H. .... 59 Milk St., Fitchburg, Mass.
SILVERMAN, MAX .... 26 Lawrence Park, Dorchester, Mass.
WHITNEY, HARRY L. .... 38 Wallace St., Somerville, Mass.

CHANGES IN ADDRESS.

ADAMS, EDWARD P. .... 1112 Exchange Bldg., Boston, Mass.
BARNES, RODERICK S. .... Randolph, N. H.
BAYLEY, FRANK A. .... Box 330, Hyannis, Mass.
BOWERS, GEORGE W. .... 3200 Franklin Ave., Cleveland, Ohio

Cashman, John M. . . . . 14 Beacon St., Boston, Mass.
Drummond, John M. . . . . 30 Orchard St., Jamaica Plain, Mass.
Goodell, John M. . . . . 106 Lorraine Ave., Upper Montclair, N. J.
Morse, Charles F. . . . . Hotel Pontiac, Good Ground, Suffolk Co., N. Y.
Pinkham, Millard B. . . . . 141 Monroe St., Brooklyn, N. Y.
Sokoll, Jacob M. . . . . 239 Shelton Ave., New Haven, Conn.
Stratton, George E. . . . . Saco, Mont.
Treadwell, Edward D.,
Engineer's Office, City Hall, Webster Groves, Mont.
Winsor, Frank E. . . . . 228 Atlantic Ave., Providence, R. I.

DEATHS.

Keppler, Theodore L. . . . . May 24, 1915
Moulton, Lorenzo G. . . . . June 9, 1915
Brackett, Dexter . . . . August 26, 1915

EMPLOYMENT BUREAU.

The Board of Government maintains an employment bureau for the Society, to be a medium for securing positions for its members and applicants for membership, and also for furnishing employees to members and others desiring men capable of filling responsible positions.

At the Society room two lists are kept on file, one of *positions available* and the other of *men available*, giving in each case detailed information in relation thereto.

Men Available.

316. Age 29. Student for three years in civil engineering courses at Harvard Univ.; student in evening courses in mechanical and electrical engineering at Mass. Inst. of Technology. Is junior member of Am. Soc. C. E. and associate member of Am. Inst. E. E. Experience includes one year as transitman of Metropolitan Water and Sewerage Bd. and six years on electric railway work as draftsman, chief of party, resident engineer, superintendent of underground construction, etc. Desires position in line with this experience.

317. Age 20. Student for two years at Tufts College. Experience consists of six months' field work and three months' class work at Tufts. Desires position as rodman. Salary desired, $8 per week.

320. Age 26. Student for four years at Dartmouth College and for

one year at Thayer School of Civil Engineering. Has had nearly three years' experience, including four months as chainman on construction with New Haven R. R. Co., and more than two years as draftsman with iron and steel company. Desires position on construction work. Salary desired, $70 per month.

321. Age 23. Graduate of Univ. of Maine, 1915. Has had some experience during summer vacations as rodman with Bay State Street Ry. Co., and as draftsman with Mass. Harbor and Land Comm. Desires position as rodman, transitman or draftsman. Salary desired, $2 per day.

324. Age 33. Received education at universities of Maine and Vermont. Has had about thirteen years' experience, including three years with Providence Steel and Iron Co. on roof and bridge design; one and one-half years with Cheney Bigelow Wire Works on design of elevators and elevator enclosures; eight months as assistant engineer in charge of field work for the City of Woonsocket, R. I.; one year as instructor in civil engineering, Univ. of Maine; and five years of municipal and construction work; is familiar with concrete construction. Salary desired, $1,200 per year.

325. Age 26. Received technical education from I. C. S. courses. Has had seven years' experience as a transitman; considers himself good draftsman and letterer. Salary desired, $3 per day.

326. Age 29. Received degree of B.S., Univ. of Vermont, 1909. Experience includes one year on dam, bridge and road construction; nine months with N. Y. C. & H. R. R. R. on grade-crossing work; one year as resident engineer with Grand Trunk Pacific Ry.; and fifteen months on New York subways. Desires position as assistant engineer. Salary desired, $115 per month.

327. Age 21. Was student for two years at Lowell Inst.; is now student in I. C. S. course in concrete engineering. Experience includes two and one-half years as draftman and estimator; six months as chainman and rodman; four months as labor foreman; has passed state examination as junior engineer. Desires position as timekeeper, rodman or estimator. Salary desired, $12 per week.

LIBRARY NOTES.

Recent Additions to the Library.

U. S. Government Reports.

Abstract of Special Bulletins on Wealth, Debt and Taxation, 1913.

Analysis and Grading of Creosotes. Arthur L. Dean and Ernest Bateman.

Annual Reports of Reclamation Service for 1912–13 and 1913–14.

Coalville Coal Field, Utah. Carroll H. Wegemann.

Contributions to Economic Geology, 1913: Part I. Metals and Non-metals except Fuels. F. L. Ransome and Hoyt S. Gale.

Cypress and Juniper Trees of Rocky Mountain Region. George B. Sudworth.

Progress Reports of Experiments in Dust Prevention and Road Preservation, 1914.

Estimation of Moisture in Creosoted Wood. Arthur L. Dean.

Eucalypts Cultivated in United States. Alfred James McClatchie.

Geology and Coal Resources of North Park, Colorado. A. L. Beekly.

Gold-Platinum-Palladium Lode in Southern Nevada. Adolph Knopf.

Utilization and Management of Lodgepole Pine in Rocky Mountains. D. T. Mason.

Production of Lumber in 1913.

Mineral Deposits of Santa Rita and Patagonia Mountains, Arizona. Frank C. Schrader.

Naval Stores Industry. A. W. Schorger and H. S. Betts.

Oil-Mixed Portland Cement Concrete. Logan Waller Page.

Preservative Treatment of Loblolly Pine Cross-Arms. W. F. Sherfesee.

Primer of Wood Preservation. W. F. Sherfesee.

Portland Cement Concrete Pavements for Country Roads. Charles H. Moorefield and James T. Voshell.

Relation of Southern Appalachian Mountains to Development of Water Power. M. O. Leighton, M. R. Hall and R. H. Bolster.

Rules and Specifications for Grading of Lumber. E. R. Hodson.

Seasoning of Timber. Hermann von Schrenk.

Results of Spirit Leveling in Idaho, 1896 to 1914, inclusive. R. B. Marshall.

Results of Spirit Leveling in Minnesota, 1897 to 1914, inclusive. R. B. Marshall.

State Management of Public Roads: Its Development and Trend. J. E. Pennybacker.

Water Supply Papers 222, 225, 226, 239, 276, 279, 282, 286, 291, 294, 298, 340-D, 340-H, 340-I, 340-J, 345-H, 345-I, 375-A. Twelve numbers gift of C. W. Sherman.

What Forestry has Done. Treadwell Cleveland, Jr.

Wood Using Industries of New Jersey. Albert H. Pierson.

State Reports.

Maine. Annual Report of Railroad Commissioners for 1914.

Massachusetts. Annual Report of Gas and Electric Light Commissioners for 1914.

Massachusetts. Annual Report of Harbor and Land Commissioners for 1914.

Massachusetts. Annual Report of Metropolitan Park Commission for 1914.

Massachusetts. Annual Report of Metropolitan Water and Sewerage Board for 1914.

New Jersey. Geology of New Jersey, 1915. J. Volney Lewis and Henry B. Kümmel.

New Jersey. Indian Habitations in Sussex County. Max Schrabisch.

New York. Annual Reports of Public Service Commission for First District: Vol. II for 1913 and Vol. I. for 1914.

New York. State Department of Labor, Industrial Board: Rules on Sanitation of Factories and Mercantile Establishments.

North Dakota. Reports and Bulletins of Agricultural Experiment Station as follows: Annual Report for 1912, Part III: Waters, Wheats, Paints, Oils, and Farm Products; North Dakota Paint Tests; Paints and their Compositions, by E. F. Ladd and C. D. Holley; Some Ready Mixed Paints, by E. F. Ladd and G. A. Abbott; Paints: Their Service Condition, by E. F. Ladd and E. E. Ware; Paint Bulletins 1 to 4, and Vol. I, 5 and 6.

Rhode Island. Annual Report of Commissioner of Dams and Reservoirs for 1912.

Rhode Island. Annual Reports of Railroad Commissioner for 1895, 1896, 1899, 1901–11, inclusive.

Rhode Island. Annual Reports of Public Utilities Commission, 1912–14, inclusive.

Wisconsin. Geological and Natural History Survey: Limestone Road Materials of Wisconsin. W. O. Hotchkiss and Edward Steidtmann.

Municipal Reports.

Baltimore, Md. Annual Report of Sewerage Commission for 1914.

Bangor, Me. Annual Report of Water Board for 1914.

Beverly, Mass. Annual Report of Department of Public Works for 1914.

Boston, Mass. Annual Report of City Planning Board for 1914.

Brockton, Mass. Annual Reports of City Engineer and Sewerage Commissioners for 1911, 1912 and 1914.

Cambridge, Mass. Report of Special Committee on Study of Local Real Estate Assessment Situation. Gift of C. M. Spofford.

Fall River, Mass. Annual Report of Watuppa Water Board for 1914.

Marlborough, Mass. Annual Report of Water and Sewage Commission for 1914.

Medford, Mass. Annual Report of Water and Sewer Department for 1914.

New Orleans, La. Semi-Annual Report of Sewerage and Water Board, December, 1914.

New York, N. Y. Annual Report of Board of Water Supply for 1914.

New York, N. Y. Annual Report of Department of Water Supply, Gas and Electricity for 1914–15.

Northampton, Mass. Annual Reports of City Officers for 1914.

Northampton, Mass. Annual Report of Water Commissioners for 1914.

Philadelphia, Pa. Report on Collection and Treatment of Sewage, 1914.

Philadelphia, Pa. Annual Report of Bureau of Surveys for 1914.

Providence, R. I. Annual Reports of City Engineer and of Commissioner of Public Works for 1908–14. 2 vols. Gift of Otis F. Clapp.

Waltham, Mass. Annual Reports of City Engineer for 1914.

Woburn, Mass. Annual Report of Water Department for 1914.

Worcester, Mass. Report of Special Commission on Collection and Disposal of Municipal Waste, 1914. Gift of Frederic Bonnet, Jr.

Miscellaneous.

American Society of Mechanical Engineers: Rules for Construction of Stationary Boilers and for Allowable Working Pressures, 1914.

Apportionment of Cost of Highway Bridges between Street Railways and Cities. Charles M. Spofford. Gift of author.

De Aquaeductibus Urbis Romae Commentarius. Sextus Iulius Frontinus. Gift of Desmond FitzGerald.

Babcock & Wilcox Co.: Steam Superheaters.

Brooklyn Engineers' Club: Proceedings for 1914.

Canada, Department of Mines: Petroleum and Natural Gas Resources of Canada, Vol. I, by Frederick G. Clapp and Others; Products and By-Products of Coal, by Edgar Stansfield and F. E. Carter.

Determination of Biochemical Oxygen Demand by Saltpeter Method in Stockyards, Tannery and Corn Products Wastes. Arthur Lederer.

Plan for Functional Organization of Engineering Work of City of New York. William W. Bush.

Great Lakes Dredge and Dock Co.; Premolded Reinforced Concrete Piles and Poles.

National Board of Fire Underwriters: Progress Report on Follow-up Work and Reports on following cities: Akron, Ohio; Alexandria, Va.; Allentown, Pa.; Atlanta, Ga.; Augusta, Ga.; Bay City, Mich.; Bloomington, Ill.; Camden, N. J.; Canton, Ohio; Charleston, W. Va.; Chattanooga, Tenn.; Chester, Pa.; Columbus, Ohio; Danville, Ill.; Dayton, Ohio; Detroit, Mich.; Duluth, Minn.; East St. Louis, Ill.; Easton, Pa.; Flint, Mich.; Fort Wayne, Ind.; Grand Rapids, Mich.; Hamilton, Ohio; Hannibal, Mo.; Haverhill, Mass.; Holyoke, Mass.; Indianapolis, Ind.; Jacksonville, Fla.; Knoxville, Tenn.; Lawrence, Mass.; Lima, Ohio; Louisville, Ky.; Lynn, Mass.; Montgomery, Ala.; New Castle, Pa.; New Orleans, La.; New Rochelle, N. Y.; Newark, Ohio; Philadelphia, Pa.; Pittsfield, Mass.; Portsmouth, Ohio; Pottsville, Pa.; Roanoke, Va.; Saginaw, Mich.; St. Louis, Mo.; St. Paul, Minn.; Salem, Mass.; Savannah, Ga.; Sheboygan, Wis.; Shreveport, La.; Springfield, Ohio; Superior, Wis.; Tampa, Fla.; Toledo, Ohio; Waltham, Mass.; Watertown, N. Y.; Wheeling, W. Va.; Williamsport, Pa.

Notes on Practical Application of "Saltpeter Method" for Determining Strength of Sewages. Arthur Lederer.

Some Paint and Painting Factors. H. Lowe.

Permeability Tests on Gravel Concrete. Morton O. Withey.

Our late Past President, Alexis H. French, has bequeathed to the Society the sum of one thousand dollars, the income of which is to be at the disposal of Mrs. French during her lifetime, and after that to be devoted to the improvement of the Society's library.

The Society has also had two bequests from the estate of our late associate, Edmund K. Turner, one of the sum of one thousand dollars — the income of same to be used for the library — and the other of the engineering books in his library, numbering over one thousand volumes. It has not been deemed advisable to publish in the JOURNAL the list of titles of these

volumes, on account of its length, but the list may be consulted at the Society rooms.

In accordance with the vote passed at the last meeting, authorizing the Committee on the Library to make such rules in relation to the circulation of books in the library as they deemed advisable, the following rules have been adopted:

Books and periodicals may be used in the Society rooms by members and friends.

Members may borrow books for home use — with the exceptions noted below — but no one shall have more than four books at any time, or keep any book more than two weeks.

Volumes belonging to a set — such as volumes of bound periodicals and of proceedings or transactions of societies — and such other books as the Board of Government may designate, may be taken from the rooms for a limited time only, by special arrangement with the attendant. They shall be subject to recall at any time.

There shall be no immediate renewal of any book on its return to the library.

A member borrowing a book shall at that time give a receipt therefor.

A fine of one cent per day per volume shall be charged for overtime, and must be paid before the delinquent can take any more books.

Handbooks, indexes, current numbers or unbound files of periodicals, books belonging to the Clemens Herschel Special Library, and new books not yet placed on the regular shelves must not be taken from the rooms.

Books of unusual value are marked with a star (*), and must not be taken from the rooms, except by written permission from the Librarian, to be filed by the attendant.

Any person mutilating or losing a book shall pay for the damage, or replace the book.

Any one who violates the above rules may, upon written request from the Librarian to the Board of Government, be debarred from the privileges of the library for such time, not less than three months, as the Board of Government may determine.

(Revised June 16, 1915.)

LIBRARY COMMITTEE.

NEW ENGINEERING WORK.

(Under this head a brief description of new engineering work contemplated or under construction will be presented each month. Engineers and contractors are requested to send descriptions of their work to the Secretary, 715 Tremont Temple, Boston, before 1st of each month.)

Commonwealth of Massachusetts. — METROPOLITAN WATER AND SEWERAGE BOARD.—*Sewerage Works.* Work is in progress on Sections 105 and 106 of the Wellesley Extension Sewer.

Work contemplated consists of lowering the Malden River siphon and extending the Deer Island outfall sewer.

METROPOLITAN PARK COMMISSION. — *Charles River Reservation.* — Plans and specifications have been prepared, and it is expected to call for bids in the near future for bridge over the Charles River at North Beacon St., Boston and Watertown.

Plans and specifications are being prepared for bridge over the Charles River at Commonwealth Ave., between Newton and Weston.

Furnace Brook Parkway. — Work of constructing parkway extension from Quincy Shore Reservation to Hancock St. is in progress. John Cashman & Sons Co., contractors.

Contract for building reinforced concrete girder bridge across Blacks Creek, for Furnace Brook Parkway Extension, has been awarded to the Hugh Nawn Contracting Co., and work will commence immediately.

Mystic Valley Parkway. — Work of constructing parkway from Cradock Bridge to Mystic Ave. is in progress. Coleman Brothers, contractors.

Contract has been awarded to Coleman Brothers for excavating and dredging the channel of Aberjona River from Boston & Maine Railroad to Walnut St., Winchester. Work is to be commenced immediately.

Revere Beach Reservation. — Bids have been received for building reinforced-concrete shore protection of the bleacher form at Revere Beach Reservation.

City of Boston. — PUBLIC WORKS DEPARTMENT, HIGHWAY

Division, Paving Service. — Work is in progress on the following streets:

West Broadway,	Dorchester Ave. to Dorchester St.	Art. stone sidewalks.
Idlewild St.,	Commonwealth Ave. to Brainerd Rd.	Bitulithic.
Lake St.,	Commonwealth Ave. to Washington St.	Art. stone sidewalks.
Spring St.,	Gardner St. to Webster St.	Bituminous macadam.
Temple St.,	Spring St. to Ivory St.	Excavating and grading.
Hillcrest St.,	Elgin St. to Temple St.	Excavating and grading.
Howitt Rd.,	Bellevue St. to LaGrange St.	Bituminous macadam.
Chapin Ave.,	Mt. Vernon St. to Preston Rd.	Tar macadam.
Fletcher St.,	Centre St. to Montclair Ave.	Bituminous macadam.
Pelton St.,	Park St. to W. Roxbury Parkway.	Bituminous macadam.
Park St.,	Centre St. to Montview St.	Art. stone sidewalks.
Augustus Ave.,	Poplar St. to beyond Clarendon St.	Tar macadam.
Birch St.,	Penfield St. to Dudley Ave.	Bitulithic pavement.
Poplar St.,	Sycamore St. to Brown Ave.	Art. stone sidewalks.
Oakland St.,	River St. to Rockdale St.	Bituminous macadam.
Seaver St.,	Blue Hill Ave. to Walnut Ave.	Excavating and grading.
Claxton St.,	Blue Hill Ave. to Callender St.	Asphalt pavement.
Callender St.,	Claxton St. to Tucker St.	Art. stone sidewalks.
Claybourne St.,	Dakota St. to Park St.,	Bitulithic pavement.
Lithgow St.,	Talbot Ave. to Wainwright St.	Excavating and grading.
Peacevale Rd.,	Norfolk St. to Dunbar Ave.	Asphalt pavement.
Lingard St.,	Magnolia St. to Hartford St.	Bitulithic pavement.
Public Alley No. 908,	Mass. Ave. to Marlborough St.	Brick block pavement.

Public Works Department, Sewer and Water Division, Sewer Service. — The following work is in progress:

In Delhi St., Mattapan; Mattapan Brook Conduit, 4′–9″, 4′–6″ and 4′–3″ circular concrete, and 15″ and 12″ pipe sanitary sewer.

Richfield and Westwood Sts., Dorchester, circular concrete surface drain, 3′–9,″ 3′–6″ and 3′–3″.

Temple St. Brook Conduit in Chiswick Rd., Tarleton and Elgin Sts., West Roxbury, sizes 6′–0″ to 3′–6″ circular concrete.

Glendower Rd., West Roxbury, 3′–3″ circular concrete surface drain.

Condor St., East Boston, 2′–6″ circular concrete surface drain and 10″ pipe sanitary sewer.

Vol. II SEPTEMBER, 1915 No. 7

BOSTON SOCIETY OF CIVIL ENGINEERS
FOUNDED 1848

PAPERS AND DISCUSSIONS

SOME SPECIAL METHODS OF REINFORCED CONCRETE DESIGN.

By M. J. Lorente.*

(To be presented September 15, 1915.)

The field of reinforced concrete has proved a sort of Promised Land to the modern engineer, especially if he be young, energetic and ambitious.

Until a very few years ago, the subject was practically a novelty and only a few pioneers had ventured to explore its mysteries. But, as is usually the case when an exploration leads to an important and lucrative discovery, the pioneers were soon followed by a host of the rank and file of the profession, eager for both the laurels and the pelf which they imagined to be easy of acquisition in the newly discovered field. However, in spite of this invasion of eager workers, the field still remains a wide one, as shown by the very many points on which authorities disagree. A notable instance of this is the "Mushroom System," which mushroom, by the way, must belong to one of the poisonous varieties, to judge by the innumerable and bitter discussions which have been raging about it.

* Civil Engineer, Lynn, Mass.

Note. This paper is issued in advance of the date set for its presentation. Discussion is invited, to be received by Edward C. Sherman, Editor, 6 Beacon Street, Boston, before November 10, 1915, for publication in a subsequent number of the Journal.

Unfortunately, those who style themselves with the well-nigh comprehensive title of "Civil Engineer" must be, above all, practical men. By this I do not mean to cast a slur on the members of the other branches of engineering. What I mean is that the civil engineer, in order to be successful and make a name for himself, must be in actual practice and in such a position as to be able to carry his ideas into effect. A mechanical engineer can theorize *ad libitum* and proceed to put his ideas into practice by means of models which may be within the reach of a moderate income, but the nature of a civil engineer's work is such that models are of practically no use whatsoever. He must, as a rule, experiment on full-sized structures, which, of necessity, entail a considerable expenditure of money, and for this reason most civil engineers have to content themselves with theorizing till Dame Fortune offers them the opportunity to give their ideas tangible form. Dame Fortune being somewhat sparing with her favors, the majority of us must perforce remain satisfied with theorizing, and this is perhaps the chief reason why reinforced concrete literature is so abundant, especially as regards methods of design.

It is with a certain degree of timidity, therefore, that I venture to add my little quota to reinforced concrete literature by offering to the members of this Society a few suggestions which will tend to facilitate the design of T-beams and of beams with steel in compression.

The method universally employed in analyzing reinforced concrete beams with steel in the tension side only has given rise to a few simple formulæ which render the operation of design extremely simple. If we know the values of R, the coefficient of resistance, and of p, the ratio of cross-sectional area of steel in tension to cross-sectional area of beam, for any given stresses, we can find the beam section to resist a given bending moment in an extremely short time. And as both R and p can easily be tabulated for various stresses, the design of such beams is simplicity itself.

It must be noticed that, in order to tabulate the values of R and p, we must find the value of the arm of the internal couple which resists the bending forces. Because of the uniformity of

the material on the compression side and of the simple geometry of a rectangular beam reinforced on the tension side only, the value of the arm can easily be found. But when we come to consider beams with steel in the compression side and T-beams, the values of the arms of the resisting couples are exceedingly troublesome quantities to deal with. In one case the heterogeneousness of the materials in the compression side, and in the other, the comparatively intricate geometry of the cross-section of the beam, complicate the expressions for the arm to such an extent as to make them absolutely impractical.

In dealing with beams with steel in compression and T-beams, authorities have thus far followed the same analytical methods used in deriving expressions for beams with steel in tension only and their efforts have been rewarded with such formulæ as the following one which gives the value of the arm of the resisting couple in a T-beam:

$$Kd = \sqrt{\frac{2ndA_s + (b_1 - b)t^2}{b} + \left(\frac{nA_s + (b_1 - b)t}{b}\right)^2} - \frac{nA_s + (b_1 - b)t}{b}$$

from which it would appear that the arm of a T-beam looks as fearsome and is as long as the famous "arm of the law."

Such a formula seems calculated to strike terror into the heart of a designer and is a contributory cause to the sneering attitude assumed by the so-called practical man towards his technical brother. And in this case the practical man, we must confess, is perfectly justified in his attitude, for the formula has none but an academic value. As a matter of fact, it is absolutely unnecessary to find the values of the arms of the resisting couples of beams with steel in compression and of T-beams, and their design can best be accomplished by entirely ignoring such values. This I propose to demonstrate in the following explanation of methods which I believe are entirely new.

Design of T-Beams.

Let us have a T-beam *ABHGJIFE* (Fig. 1).

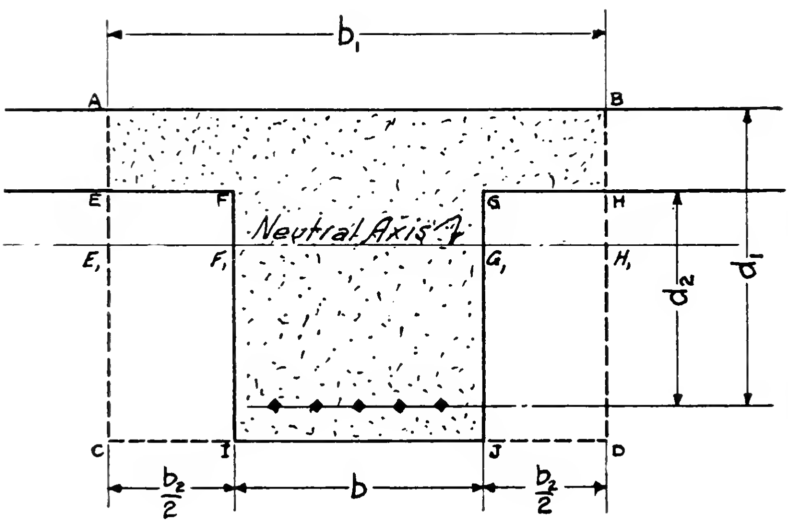
The moment of resistance of the "T" will clearly be equal to that of a rectangular beam *ABDC* less those of two rectangular beams *EFIC* and *HDJG*.

Likewise, the area of steel required for the "T" will be that required for a rectangular beam *ABDC* less that required for the two beams *EFIC* and *HDJG*. That these statements are correct can be proven by the elementary principles of beam sections thus:

$$\text{R. M.} = \frac{E}{\rho}\Sigma a y^2 + \frac{E}{\rho}\Sigma a_1 (y^1)^2$$

$$= \frac{f}{y}\Sigma a y^2 + \frac{f_1}{y_1}\Sigma a_1 (y^1)^2$$

$$\text{or} \quad = \frac{f_c}{y_c}\Sigma a_c y^2 + \frac{f_s}{y'_s}\Sigma a_s (y^1)^2.$$



—Fig. 1—

In the T-beam Σa_c will be the area $AE_1H_1B—EE_1F_1F—GG_1H_1H$, and Σa_s will be the area of steel required for the large beam less the areas required for the smaller beams. We thus have reduced to rectangular beams the problem of a T-beam.

Expressing the above statements in formulæ, we have:

$$M = R_1 b_1 d_1^2 - R_2 b_2 d_2^2$$

and

$$A = p_1 b_1 d_1 - p_2 b_2 d_2,$$

where

M = bending moment in inch-pounds;

A = required area of steel in square inches;

R_1 = coefficient of resistance for the large beam ($ABDC$);

R_2 = coefficient of resistance for the small beams ($EFIC$ and $HDJG$);

p_1 = ratio of area of steel to effective area of beam $ABDC$;

p_2 = ratio of area of steel to effective area of beams $EFIC$ and $HDJG$.

It should be borne in mind that the steel stresses will be the same for both the large and the small beams, but the stresses in the concrete will be different. In the large beam the stress will be the maximum allowable, while in the small beams the stresses will be those corresponding to the fibers in the underside of the slab forming the wings of the "T." If we know the position of the neutral axis we can easily find them by simple proportion. Now it is this stress in the concrete in the under side of the slab which determines the values of R_2 and p_2.

Suppose, now, that we had a table giving the values of the constants R, p and k (where k is the coefficient which, multiplied by the effective depth of the beam, gives the depth of the neutral axis below the top of the beam) for a given stress in the steel and a given ratio of moduli. Then, after determining by simple proportion the stress in the under side of the slab we could pick out the required constants. If we had a beam 25 ins. deep and with a slab 6 ins. deep, and if the allowable stresses were 18 000 lbs. per sq. in. for the steel and 800 lbs. per sq. in. for the concrete, and the ratio of moduli were 12, we would find that the stress in the under side of the slab would be—

$$\left(k - \frac{t}{d}\right)\frac{f_c}{k} = 250 \text{ lbs. per sq. in.,}$$

where t is the thickness of the slab. Then from the accompanying Table 1 we could obtain directly the constants—

$$R_1 = 123,\ p_1 = 0.0077,\ \text{and}\ R_2 = 17,\ p_2 = 0.001.$$

In order to avoid interpolating for values not given in the table, and to simplify at the same time the operation for finding the stress in the underside of the slab, a set of curves could be made for given stresses in the steel and given ratios of moduli similar to those shown in Figs. 2 to 7, inclusive. The method of using the curves is as follows.

Along the scale of $\frac{t}{d}$ take the required value. From this point follow a perpendicular line till it meets the oblique line marked with the maximum stress allowable in the concrete. From this point of intersection follow a line parallel to the scale of $\frac{t}{d}$ till it meets the curves marked R and p, and read the corresponding values in the respective scales. These values are those of R_2 and p_2. The values of R_1 and p_1 can be obtained by following a parallel line from the point where the oblique line marked with the maximum allowable stress in the concrete meets the perpendicular from the zero point of the $\frac{t}{d}$ scale.

In actual practice, the formulæ given above have to be slightly modified. Thus, if we want to design a beam we have—

$$M = R_1 bd_1^2 + R_1 b_2 d_1^2 - R_2 b_2 d_2^2;$$
$$A = p_1(b+b_2)d_1 - p_2 b_2 d_2.$$

For purposes of reviewing a beam, the formulæ as already given are sufficient.

It should be noticed that this method, besides being simpler than those in common use, does not neglect the compression in the stem of the beam.

Design of Beams with Steel in Compression.

Referring to Fig. 8, showing the cross-section of a beam reinforced with steel in the compression side, the moment of resistance of the concrete in compression is

$$\tfrac{1}{2} bkjd^2 f_c,$$

and the moment of resistance of the steel in compression is

$$\frac{p^1 bd^2 rf_c n(kd - d + rd)}{kd}.$$

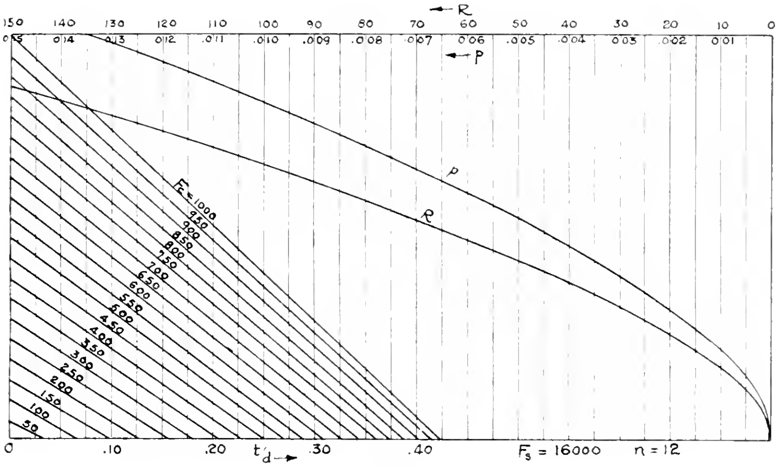

← R
150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
0.15 0.14 0.13 0.12 .011 .010 .009 .008 .007 .006 .005 .004 .003 .002 0.01
← p
p
R
F_c = 1000
950
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0 .10 .20 t/d → .30 .40
F_s = 16000 n = 12

FIG. 2.

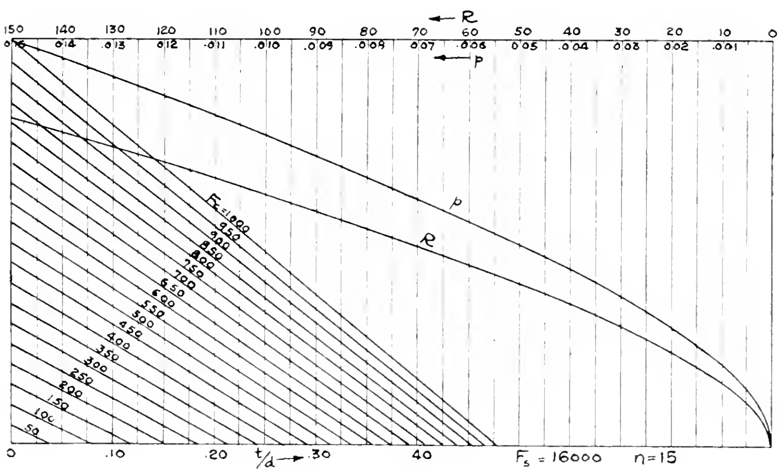

← R
150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
0.15 0.14 .013 0.12 .011 .010 .009 .008 .007 .006 .005 .004 .003 .002 .001
← p
p
R
F_c = 1000
950
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0 .10 .20 t/d → .30 40
F_s = 16000 n = 15

FIG. 3.

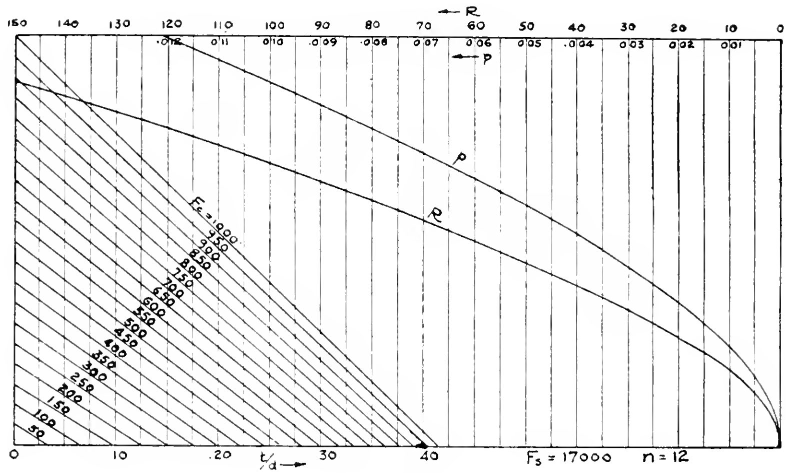

R
150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
.012 0.11 0.10 .009 .008 0.07 0.06 0.05 .004 0.03 0.02 0.01
p
p
R
F_c = 1000
950
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0 10 .20 t/d 30 40
F_s = 17000 n = 12

FIG. 4.

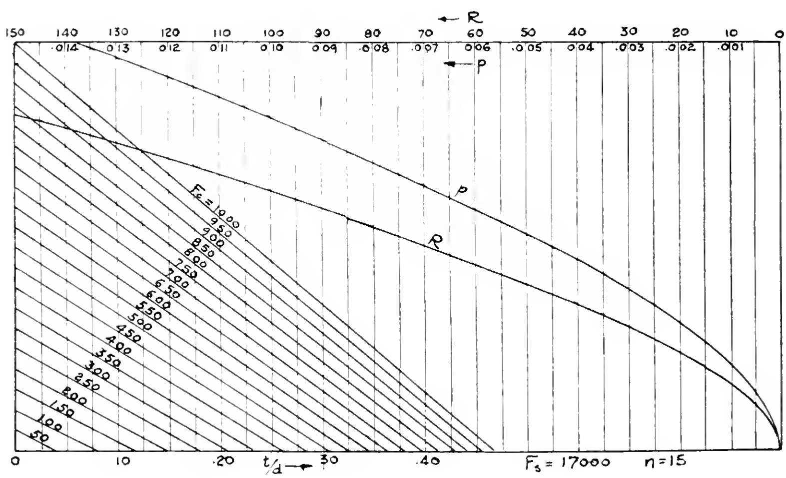

R
150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
.014 0.13 0.12 0.11 0.10 0.09 .008 .007 0.06 .005 0.04 .003 .002 .001
p
p
R
F_c = 1000
950
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0 10 .20 t/d 30 .40
F_s = 17000 n = 15

FIG. 5.

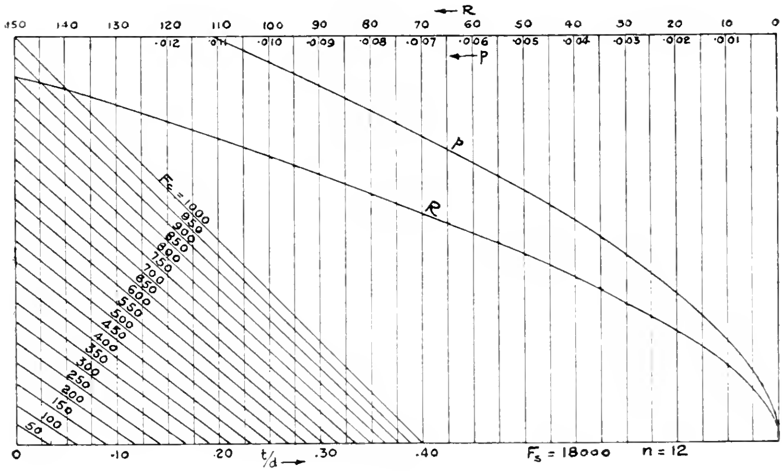


FIG. 6.

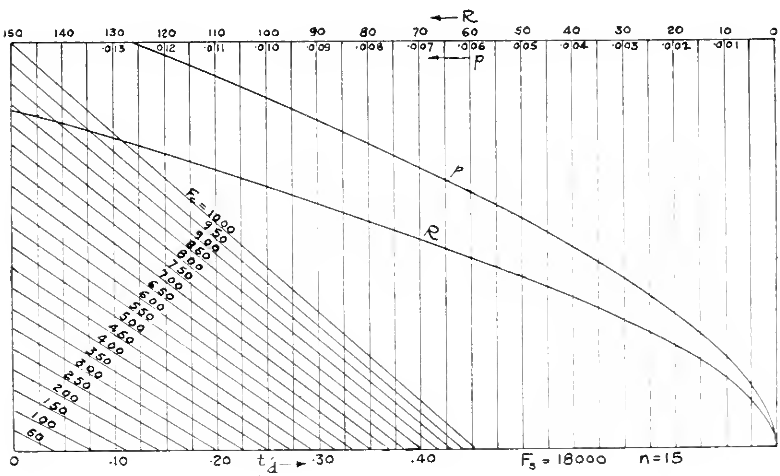


FIG. 7.

If the two moments be equal, that is to say, an area of steel $= p^1bd$ would have the same value as the area of concrete bkd, —

$$p^1 = \frac{jk^2}{2nr(k - 1 + r)}.$$

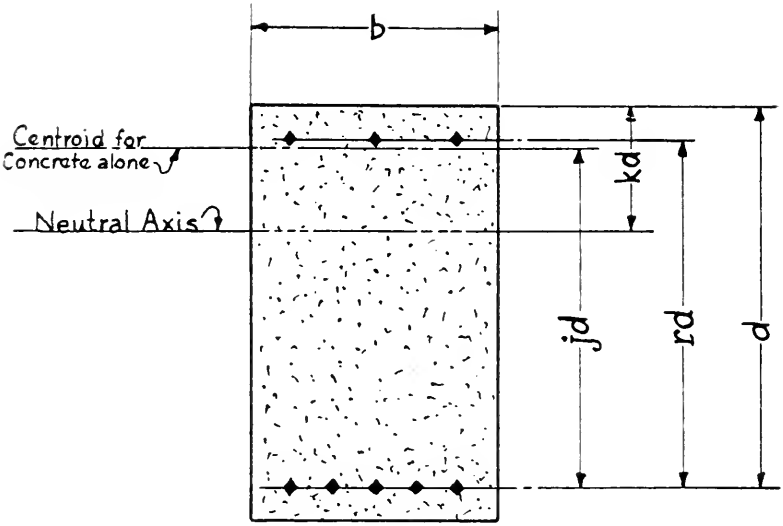


FIG. 8.

From which we see that p^1 is a constant for given stresses, etc., and for a given r.

If M = bending moment in the beam,

$$M = \tfrac{1}{2} x b d^2 k j f_c,$$

where x is the number of times which the area of concrete in compression or its equivalent area of steel in compression must be used to resist the bending moment.

Hence,

$$p^1 bd(x - 1) = p_c bd;$$

where p_c is the required ratio of steel in compression.

Therefore,

$$x = 1 + \frac{p_c}{p^1};$$

and the formula becomes

$$M = \left(1 + \frac{p_c}{p^1}\right) bkjd^2 \frac{f_c}{2} = (p_c + C_2)\frac{bd^2}{C_1}.$$

Hence, $$p_c = \left(\frac{MC_1}{bd^2}\right) - C_2 \text{ and } d = \sqrt{\frac{MC_1}{b(p_c + C_2)}}.$$

The moment of resistance of the steel in tension corresponding to the concrete in compression $= p_1 bjd^2 f_s$.

The moment of resistance of the steel in tension corresponding to the steel in compression $= p_2 brd^2 f_s$.

If the two moments be equal, then $p_1 j = p_2 r$.

Now, $M = x p_1 bjd^2 f_s$,

where x is the number of times which $p_1 jbd^2$ or its equivalent $p_2 rbd^2$ must be used to resist the bending moment.

Hence, $(x-1) p_2 brd^2 = p_3 brd^2$.

Therefore, $p_3 = (x-1) p_2 = (x-1) p_1 \frac{j}{r}$.

And $x = \left(\frac{p_3 r}{jp_1}\right) + 1 = 1 + \frac{p_c}{p^1}$.

Therefore, $p_3 = p_c p_1 \frac{j}{p^1 r} = C_3 p_c$.

And, finally, total area of steel in tension $= (p + C_3 p_c) bd$, where p is the ratio of steel in tension for a beam which has no steel in compression, and p_c is the ratio of steel in compression as found in one of the equations above. It should further be noticed that jd, in the above equations, is the distance of the centroid of the compressive forces in the concrete *alone* from the center of gravity of the steel in tension.

TABLE 1.

F_c.	k.	p.	R.
1000	.400	.01110	174.00
950	.388	.01020	160.00
900	.376	.00950	149.00
850	.362	.00850	134.00
800	.348	.00770	123.00
750	.334	.00700	112.00
700	.316	.00620	100.00
650	.302	.00550	89.00
600	.286	.00480	78.00
550	.268	.00410	67.00
500	.250	.00350	59.00
450	.231	.00290	48.00
400	.211	.00230	38.50
350	.190	.00190	32.00
300	.167	.00140	24.00
250	.143	.00100	17.00
200	.118	.00065	11.00
150	.091	.00039	6.80
100	.062	.00017	3.00
50	.032	.00005	0.89

$F_s = 18\,000$. $n = 12$.

TABLE 2.

$F_s = 18\,000$	$n = 15$.			$n = 12$.		
	C_1.	C_2.	C_3.	C_1.	C_2.	C_3.
$F_c = 600$	.000167	.0131	345	.000133	.0117	440
	186	.0146	316	144	.0128	410
	208	.0163	289	158	.0141	380
	237	.0185	260	174	.0156	350
	271	.0212	233	185	.0175	320
	315	.0246	205	222	.0198	290
	375	.0293	176	253	.0226	260
	455	.0356	148	293	.0262	230
	580	.0453	119	347	.0310	200
$F_c = 650$	.000154	.0136	378	.000120	.0121	482
	170	.0150	350	131	.0133	448
	188	.0167	322	144	.0146	417
	212	.0188	293	159	.0161	387
	240	.0213	263	176	.0178	357
	276	.0245	234	198	.0200	323
	323	.0286	206	223	.0226	295
	386	.0342	176	257	.0260	263
	470	.0417	148	296	.0300	233
$F_c = 700$	.000148	.0141	410	.000111	.0125	522
	163	.0155	380	121	.0137	487
	181	.0172	350	132	.0149	457
	202	.0192	320	145	.0164	425
	227	.0216	296	160	.0181	393
	258	.0246	263	178	.0202	362
	299	.0285	232	200	.0226	330
	350	.0334	202	227	.0256	300
	422	.0402	173	260	.0294	267
$F_c = 750$	.000132	.0146	445	.000101	.0130	560
	144	.0160	414	111	.0141	530
	159	.0177	383	122	.0154	494
	176	.0196	353	133	.0168	463
	198	.0220	323	146	.0185	432
	223	.0248	293	162	.0205	397
	255	.0283	263	180	.0228	365
	295	.0328	233	203	.0256	333
	348	.0386	203	231	.0292	300
$F_c = 800$	.000123	.0151	47	.000097	.0134	600
	134	.0165	44	104	.0145	565
	147	.0181	408	113	.0157	533
	162	.0200	377	124	.0172	496
	181	.0223	347	135	.0188	466
	203	.0250	317	149	.0207	433
	230	.0282	287	166	.0230	398
	264	.0324	257	184	.0256	366
	307	.0377	225	202	.0290	333

TABLE 2. — *Continued.*

$F_s = 18\,000$	$n = 15$.			$n = 12$.		
	C_1.	C_2.	C_3.	C_1.	C_2.	C_3.
$F_c = 850$	.000115	.0155	505	.000090	.0137	640
	125	.0169	473	97	.0148	605
	137	.0185	443	105	.0160	572
	150	.0203	412	114	.0174	540
	166	.0225	379	125	.0191	502
	186	.0252	347	137	.0209	470
	210	.0283	316	152	.0232	433
	238	.0322	283	168	.0257	403
	274	.0370	253	188	.0287	367
$F_c = 900$	.000108	.0160	542	.000085	.0141	68
	116	.0173	512	94	.0152	645
	127	.0189	480	99	.0164	610
	139	.0207	447	108	.0178	575
	154	.0229	413	117	.0194	540
	171	.0254	380	128	.0212	505
	191	.0284	350	141	.0234	467
	216	.0320	317	156	.0258	435
	247	.0366	284	174	.0288	400
$F_c = 950$	.000102	.0164	565	.000081	.0144	715
	110	.0177	535	87	.0155	680
	120	.0193	500	94	.0167	645
	131	.0211	468	101	.0180	612
	144	.0232	436	111	.0198	570
	159	.0256	405	121	.0215	535
	177	.0285	372	132	.0235	500
	198	.0320	338	145	.0260	463
	225	.0363	306	161	.0288	430
$F_c = 1\,000$	.00096	.0168	602	.000077	.0147	757
	104	.0182	57	82	.0158	722
	112	.0197	535	88	.0170	685
	123	.0215	500	95	.0183	650
	135	.0236	467	103	.0198	615
	148	.0260	433	112	.0216	575
	164	.0288	402	123	.0236	541
	184	.0322	368	135	.0260	502
	207	.0362	335	249	.0287	466

TABLE 3.

$F_s = 16\,000$		$n = 15.$			$n = 12.$			
	$r.$	$C_1.$	$C_2.$	$C_3.$	$C_1.$	$C_2.$	$C_3.$	$r.$
$F_c = 600$	.96	.000167	.0139	.39	.00013	.0124	.50	.96
	.94	184	.0153	.36	142	.0135	.47	.94
	.92	204	.0170	.33	156	.0148	.436	.92
	.90	228	.0190	.304	171	.0163	.404	.90
	.88	258	.0215	.274	189	.0180	.376	.88
	.86	295	.0246	.246	211	.0201	.344	.86
	.84	342	.0285	.217	238	.0226	.314	.84
	.82	453	.0377	.168	270	.0258	.280	.82
	.80	491	.0408	.16	312	.0297	.250	.80
$F_c = 650$	.96	.000152	.0144	.433	.000120	.0129	.545	.96
	.94	166	.0158	.403	130	.0140	.513	.94
	.92	184	.0175	.372	141	.0152	.482	.92
	.90	204	.0194	.343	154	.0166	.450	.90
	.88	228	.0217	.315	170	.0183	.417	.88
	.86	259	.0246	.283	188	.0203	.385	.86
	.84	298	.0283	.252	212	.0227	.354	.84
	.82	345	.0329	.222	238	.0256	.321	.82
	.80	409	.0389	.192	270	.0291	.290	.80
$F_c = 700$	.96	.000141	.0150	.460	.000110	.0133	.591	.96
	.94	153	.0163	.435	120	.0144	.557	.94
	.92	169	.0180	.402	130	.0157	.523	.92
	.90	186	.0198	.373	142	.0171	.490	.90
	.88	208	.0221	.342	155	.0187	.459	.88
	.86	233	.0248	.312	172	.0207	.425	.86
	.84	265	.0282	.280	191	.0230	.390	.84
	.82	306	.0325	.250	214	.0258	.350	.82
	.80	357	.0380	.218	241	.0290	.326	.80
$F_c = 750$	.96	.000130	.0155	.505	.000104	.0138	.630	.96
	.94	142	.0169	.473	111	.0148	.600	.94
	.92	155	.0185	.440	120	.0160	.570	.92
	.90	170	.0203	.412	130	.0174	.533	.90
	.88	189	.0225	.380	143	.0191	.497	.88
	.86	211	.0251	.348	157	.0210	.462	.86
	.84	238	.0283	.316	174	.0232	.428	.84
	.82	271	.0323	.283	192	.0256	.398	.82
	.80	313	.0372	.253	218	.0290	.360	.80
$F_c = 800$	.96	.000122	.0160	.537	.000096	.0141	.680	.96
	.94	131	.0173	.507	103	.0152	.645	.94
	.92	143	.0189	.475	112	.0164	.610	.92
	.90	157	.0207	.443	121	.0178	.573	.90
	.88	173	.0228	.412	132	.0194	.577	.88
	.86	192	.0253	.380	144	.0211	.507	.86
	.84	215	.0283	.346	159	.0233	.470	.84
	.82	243	.0320	.314	175	.0257	.437	.82
	.80	279	.0366	.282	196	.0287	.403	.80

TABLE 3. — *Continued.*

$F_s = 16\ 000$	$n = 15.$				$n = 12.$			
	$r.$	$C_1.$	$C_2.$	$C_3.$	$C_1.$	$C_2.$	$C_3.$	$r.$
$F_c = 850$	.96	.000113	.0164	.570	.000089	.0144	.725	.96
	.94	122	.0177	.540	96	.0155	.685	.94
	.92	133	.0193	.507	104	.0167	.652	.92
	.90	145	.0210	.476	112	.0181	.615	.90
	.88	159	.0231	.443	121	.0196	.580	.88
	.86	177	.0256	.408	132	.0213	.547	.86
	.84	196	.0284	.378	145	.0235	.507	.84
	.82	221	.0320	.343	160	.0258	.473	.82
	.80	251	.0364	.309	177	.0286	.437	.80
$F_c = 900$	.96	.000107	.0168	.612	.000084	.0147	.773	.96
	.94	116	.0182	.575	90	.0158	.737	.94
	.92	126	.0197	.544	97	.0170	.698	.92
	.90	137	.0215	.510	105	.0184	.658	.90
	.88	150	.0235	.477	114	.0199	.625	.88
	.86	166	.0260	.440	123	.0216	.587	.86
	.84	184	.0287	.409	135	.0237	.549	.84
	.82	204	.0320	.376	148	.0260	.512	.82
	.80	232	.0361	.342	164	.0288	.475	.80
$F_c = 950$	.96	.000102	.0172	.649	.000080	.0151	.816	.96
	.94	110	.0186	.613	86	.0161	.780	.94
	.92	119	.0202	.575	92	.0173	.743	.92
	.90	129	.0219	.542	99	.0187	.701	.90
	.88	140	.0238	.510	107	.0203	.660	.88
	.86	154	.0262	.475	116	.0220	.625	.86
	.84	171	.0290	.440	126	.0239	.587	.84
	.82	190	.0321	.407	138	.0261	.551	.82
	.80	212	.0360	.372	153	.0288	.512	.80
$F_c = 1\ 000$	.96	.000095	.0175	.685	.000076	.0153	.86	.96
	.94	102	.0189	.647	81	.0163	.823	.94
	.92	110	.0204	.612	87	.0175	.783	.92
	.90	120	.0222	.575	93	.0188	.745	.90
	.88	130	.0241	.543	100	.0203	.705	.88
	.86	142	.0263	.507	109	.0220	.665	.86
	.84	156	.0290	.472	119	.0240	.625	.84
	.82	173	.0321	.438	130	.0262	.587	.82
	.80	193	.0358	.402	143	.0288	.548	.80

DISCUSSION.

By W. W. Clifford, Member Boston Society of Civil Engineers, and C. H. Mangold.

The writers have read Mr. Lorente's paper with a great deal of interest. The compactness with which the data are given for the computation of T-beams, for various stresses, seems to them to be of special note. Mr. Lorente's method for the computation of beams reinforced for compression is logical and simple of application.

In the matter of compression steel in concrete beams, however, it often happens that the formulæ of the 1913 report of the "Joint Committee on Concrete and Reinforced Concrete" give a more direct solution. This occurs in the investigation of stresses in beams already designed, where the percentages of steel are fixed; and in the case of compression steel over the supports of continuous T-beams, where the size of the section is determined and the areas of steel largely influenced by other conditions of design. In these cases the percentages of steel form a more direct assumption than the stresses.

The common formulæ for j* and k* in doubly reinforced beams, as given by the "Joint Committee," are so cumbersome, however, as to be prohibitive in any but infrequent cases of actual design. A number of graphical and tabular aids for the use of these formulæ have been originated and published, but in most cases they involve the use of one or more new constants. Arbitrary "L"s or "C"s are another thing with which to burden the mind, and few people ever get well enough acquainted with such constants to gain anything but arbitrary values from curves or tables relating to them.

On the other hand, with functions like the depth of the neutral axis, the moment arm or the percentages of steel, most designers are thoroughly familiar. Curves relating to these quantities, therefore, not only give definite values, but also suggest the possibilities of change in one or more of the given functions.

On this account the writers have found the accompanying

* "Joint Committee" notation used.

graphical solution of the standard formulæ to be simple and useful of application. (Fig. 9.) These are curves of j with p^1 and k as coördinates, superimposed on similar curves of p. These with the addition of Table 1, which is self-explanatory, make the necessary slide rule operations very simple.

These curves, as will be noted, are for three values of $\frac{d^1}{d}$, 0.05, 0.10 and 0.15, which will cover most practical cases. Their application is as follows: Let us assume the investigation of a beam which has an external bending moment of 1 625 000 in.-lb., $\frac{d^1}{d}=0.10$, $d=21$ in., $p=0.025$, $p^1=0.02$, and an area of tension steel of 6.30 sq. in.; n is assumed to be 15. Entering the middle group of curves $\left(\frac{d^1}{d}=0.10\right)$ at the top where the value of p^1 is 0.02, and dropping vertically down to the $p=0.025$ curve, we read $k=0.45$ and $j=.876$.

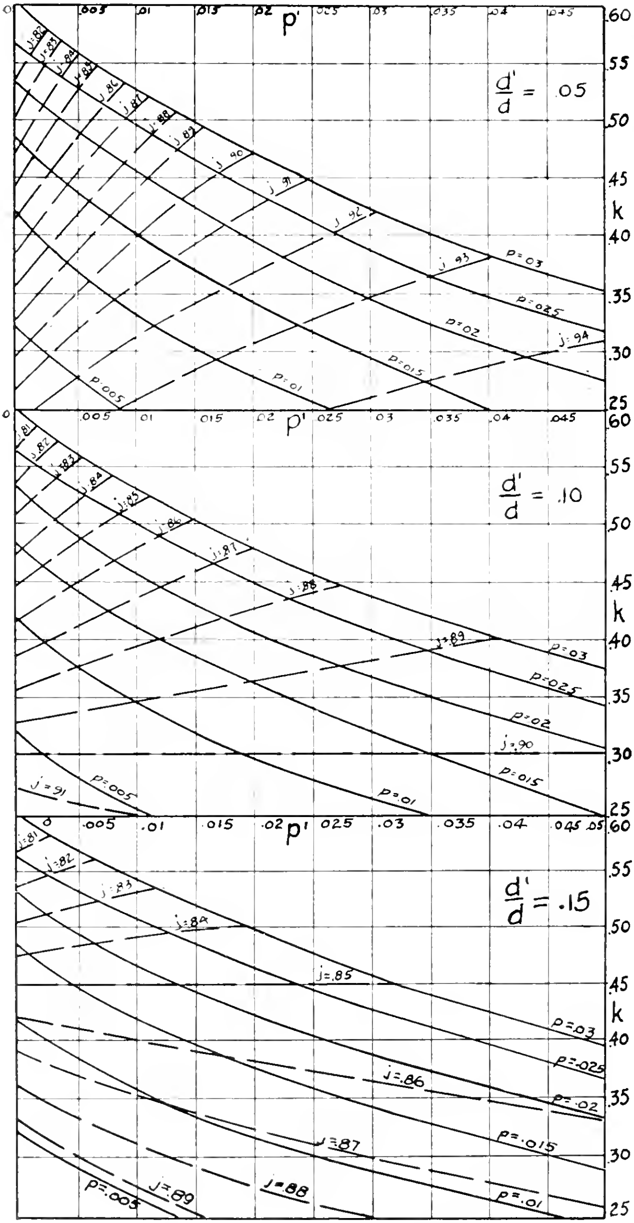
$$\text{Then } f_s=\frac{M}{Ajd}=\frac{1\,625\,000}{6.30\times0.876\times21}=14\,000 \text{ lbs. per sq. in.}$$

$$\text{and } f_c=f_s\left(\frac{1}{n}\,\frac{k}{1-k}\right)\left\{\begin{array}{l}\text{see Table 1}\\ k=0.45\ \left(\frac{1}{n}\,\frac{k}{1-k}\right)=0.545\end{array}\right.$$

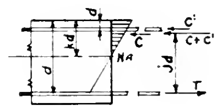
$$=.0545\times14\,000$$
$$=763 \text{ lbs. per sq. in.}$$

The writers recommend using the curves for the value of $\frac{d^1}{d}$ next larger than the actual value. This will be a small percentage on the safe side, but will be well within the precision of the actual work. But for special cases interpolation between the curves is easily made.

The writers trust that these curves may be of interest and use to others of the profession who have occasion to design or review concrete beams with compression steel.



Reinforced
Concrete Beams
with
Compression Steel.
n = 15



$$f_s = \frac{M}{Ajd}$$

$$f_c = f_s\left(\frac{1}{n} \times \frac{k}{1-k}\right)$$

'k'	$\left(\frac{1}{n} \times \frac{k}{1-k}\right)$
.25	.0222
.26	233
27	245
28	258
29	272
.30	.0286
.31	300
.32	314
.33	329
.34	344
.35	.0359
36	374
37	390
38	408
39	426
.40	.0444
41	463
42	482
43	502
44	523
45	.0545
.46	568
.47	591
48	615
49	640
.50	.0667
.51	693
.52	722
53	751
54	782
55	.0814
56	847
57	882
58	919
59	958
60	1000

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Fig. 9.

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PAPERS AND DISCUSSIONS

DISCUSSION OF GROUND WATER SUPPLIES.

BY ROBERT SPURR WESTON, ALLEN HAZEN, HENRY A. SYMONDS AND WILLIAM S. JOHNSON.

MR. WESTON.* — Mr. Johnson's paper has so well covered the field of ground water supply, the construction of the works, and their operation, that there is very little left for any one to say in discussion. It is good to hear a paper so full of ideas.

I think few of us realize how recent is our knowledge regarding ground water supplies. While it is true that Aristotle and some of the early Greek philosophers had the idea that the source of the ground water was the rain, which, as they expressed it, was absorbed by the mountains, and then given back to the springs and wells, the people in the Middle Ages thought that the source of ground water was the condensed steam which was produced by the seepage of the ocean water into the hot bowels of the earth. It was not until the last decade of the nineteenth century that people really began to study the subject experimentally in order to determine the laws of the flow of ground water. As Mr. Johnson states, our Massachusetts conditions, our New England conditions, with the possible exception of those which exist in the more recent deposits in the southeastern part of this state, — which are similar to those in New Jersey, — are not uniform. Except in those regions, all of the water-bearing material is heterogeneous and is not subject

* Consulting Sanitary Engineer, Boston.

to those hydrological laws which have been so well worked out by Mr. Schlicter, of the Geological Survey, and others. Out West they are able to predict almost certainly what some of the sandstones will yield when wells are sunk into them. There is a story about one of the Chicago & Northwestern Railroad engineers who sank a well at 1 500 ft. and getting discouraged called in a geologist. The advice given was so precise that water was found at about 1 600 ft. as predicted.

One of the chief advantages of ground water is its better appearance as compared with surface water. As Mr. Johnson says, it is cooler in summer and warmer in winter than the surface water. It can be used from the tap without ice, which is an advantage, and it is generally free from odor, color and objectionable taste, except when it contains iron or some of the dissolved gases from the soil. Many of the largest supplies of the world have been changed over in recent years from surface sources to ground water sources; among them, such cities as Budapest, Hamburg, Berlin, Leipsic and Dresden, all of them cities of the first class and cities which formerly were apparently well satisfied with surface water supplies. Military reasons have led many German cities to adopt the ground water supply in whole or in part; Antwerp had a surface supply which failed with the fall of Fort Woevre-St. Catherine.

Mr. Johnson applied the term " deep wells " to artesian wells also. The speaker has always been taught that deep wells are wells which are driven to a considerable depth, and artesian wells are deep wells in which water rises under pressure to a greater or less height above its source in the ground; when rising above the surface they are flowing (artesian) wells.

Mr. Johnson has emphasized a most important point, namely, the value of pumping tests. We have not always felt that the results obtained enabled us to predict the quality as well as the quantity of the water. I would cite the Middleboro water works as an example. About twenty years ago they made a pumping test and found the water to be excellent in quality and practically free from iron, and so it continued to be for several years. Then came a break; organic matter increased in the soil, the iron content rose and the water became disagreeable,

and without increasing the consumption the iron has increased threefold within the last fourteen months. This increase in iron, and with it often manganese, has been the experience with a great many supplies in eastern Massachusetts. It does not seem to be the case with supplies in the western part of the state, probably due, I think, to the larger deposits of bog iron ore in the East as compared with those in the West.

Nothing is more important, as Mr. Johnson has said, than to locate the wells as far away as possible from peat bogs. Peat bogs when inundated and thus kept away from the air, ferment and the sulphur compounds in the organic matter change over to hydrogen sulphide gas. This gas will dissolve in the water, and when brought in contact with air oxidizes to sulphuric acid, which dissolves the iron and produces with organic matter a very refractory compound. This is the situation at Reading, where the iron is dissolved by the sulphuric acid. A similar case occurred at Breslau in Germany, where the sulphuric acid dissolved so much manganese that the whole works had to be shut down for a time.

We have just finished a pumping test for a supply in Worcester County testing for 100 000 gal. per day at a 200 000 gal. rate during the whole test week. The whole cost of ten wells including the test was $1 500.

I think Mr. Johnson is to be congratulated upon this very clear presentation of an important and rather neglected subject in water supply engineering.

Mr. Hazen.* — I have been greatly interested in Mr. Johnson's paper. Twenty years ago I had the pleasure and privilege of presenting to this Society some ideas in regard to ground water supplies, and I am pleased to hear from Mr. Johnson that many of the points that I then made are still good. On the other hand, Mr. Johnson's paper shows that the methods of finding and developing such supplies have been greatly improved in recent practice in Massachusetts.

As a general proposition I have been rather skeptical of pumping tests as a means of determining permanent yielding capacities of supplies. Without attempting to give from memory

* Hazen & Whipple, Consulting Engineers, New York.

the exact capacities, the histories of a few plants may be instructive as bearing upon the reliability of pumping tests.

In one case a well plant was built as an auxiliary plant some fifteen or eighteen years ago. It was built under a contract with a guarantee to produce three million gallons per day, and it did produce the full quantity for the guaranteed period, which was I think, one year. The next year it fell somewhat short of the guaranteed capacity, but, of course, the guarantee had expired; the following year it fell still further short, and in the course of a few years the output had dropped to about one quarter of the original amount, and that amount was steadily maintained during a ten-year period. The explanation was that the valley in which this plant was located contained a big underground reservoir of pervious material. This reservoir held enough water to maintain the output during the first year, and to furnish a considerable but reducing quantity thereafter during several years. When the natural reservoir had been drained as far as the wells were capable of draining it, the output was reduced to the amount which resulted from the rainfall on the tributary area, which proved to be only a fraction of the original amount. A year's pumping test ordinarily would be considered to be an exhaustive one, but in this case it did not prove to be. The permanent yield was very much less than had been indicated by it.

In another case a ground water supply served a prosperous and growing community. As the years went by, other and deeper wells were driven from time to time to get more water. The ground water level gradually became lower, the pump pits were deepened, and afterward air lifts were put in to take the water lower. During a period of fifteen or twenty years the ground water level was gradually lowered until now it is probably from fifty to one hundred feet lower than it naturally was over an area of many square miles. This is another case of a reservoir of very great capacity which has been gradually drained and emptied by pumping water out of it. The water that has been taken has been valuable and has permitted the company that exploited it to pay for their works and pay dividends. The development was good and profitable, although not a permanent one. The water that has been taken is comparable with the coal

that is taken from a mine: there is about so much of it, and when it is gone another source of supply must be found.

In still another case a ground water supply near salt water yielded through a considerable term of years an abundant supply of water of excellent quality. Ultimately the water became brackish and not suitable for further service. In this case there was no reduction of ground water level during the period of successful pumping. The explanation is that large layers of pervious material existed below the sea level, but these were filled with fresh water of good quality which represented the accumulation of many years of surface run-off from a small tributary area. As this water was drawn by the wells the water level was not lowered because sea water came in to take its place in the voids of the pervious material. A full supply was easily maintained without lowering the ground water level until the fresh water had been so drawn out that salt water commenced to reach the wells. After that the supply was practically useless.

I cite these as illustrations of cases where pumping tests have continued for much longer periods than are usually thought sufficient to demonstrate all the conditions that there are, and which have nevertheless failed to show the permanent yielding capacities.

In California there has been a recent development in ground water supplies that has greatly increased their practical value; that is, the use of electricity for operating pumps to get water out of the wells. The electricity comes from water power in the Sierras. The electrical apparatus has been perfected so that it not only takes care of itself with only occasional inspection, but is able to stop and start itself according to the demand for water. In general a pump is used for each well, but sometimes the wells are more numerous than the pumps, and the motor and pump are taken from well to well in rotation to secure the fullest and most convenient development and use of the supply.

Mr. Symonds.* — There is one matter which I would like to mention, which Mr. Johnson referred to, and that is the question of large pipe wells in place of strainer point wells. The need of something of this kind arose in some underground water

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* Consulting Engineer, The Hanscom Construction Company, Boston.

supplies on Cape Cod. As you probably know, the Cape is largely a sand formation. There is more or less gravel, but that is mixed with a good deal of fine sand, and my experience has been that it is necessary to use strainer points of some kind in most parts of the region. We have found that after a comparatively few years strainer points of all descriptions give more or less trouble. The ordinary strainer point, such as was shown on the screen, seems to form a sort of scale over the outside of the small wire screens which practically puts them out of commission, with such water which might be found on the Cape, in about three years. We have tried to find some remedy for this trouble, which was becoming very pronounced with the wells in one plant. We studied the feasibility of the large well, but conditions were not such as to warrant putting in a large well without an expensive test, which we hesitated to make. In trying to devise some scheme by which we could get water into the wells without having the trouble of clogging up fine screens and not having to go to the expense of a large well, we undertook to sink a series of small wells, each about two feet in diameter.

The use of such wells is not new, but some of the features of the wells which we are using at the present time may be a little different from those used before for this purpose.

We find it possible to sink these wells by dredging out the interior so long as we take certain precautions in regard to keeping the pipes together. We started using cement pipes with bells. This method was satisfactory in some sections but did not work well in others, as the lower pipes sometimes dropped away from those above. But we finally devised a series of clamps which have given good results. It becomes evident as the dredging takes place in the interior of these wells that the pipes alone do not go down, causing friction on the sides, but that a certain volume of the surrounding earth, varying from six inches to a foot, gradually works down with the pipe.

These wells on the Cape have proven very satisfactory and we are now using them in some other places. In places where it has been impossible to get water with any form of small pipe well where there is a great deal of quicksand, these wells are doing good work. There are certain problems in regard to the opera-

tion and keeping the quicksand out which we are now working on, but we believe that the field for this kind of well is a fairly broad one and, developed as it should be, will help out the underground water supplies. There are a great many towns in Massachusetts where a great deal of difficulty is being experienced with well systems that might be helped by this form of well.

In regard to the pumping tests which, as Mr. Hazen has shown by some very good examples, are in many cases unsatisfactory, it seems to me, nevertheless, that for small plants such as are being largely put in at the present time in this section of the country, they have a great many advantages as well as some disadvantages, and as an illustration I might cite the case of Merrimack, N. H., where we made a lot of tests two or three years ago and found some rather unusual conditions. The water was cold, about 42° or 43°. It was analyzed and reported as very high grade by the New Hampshire State Board of Health. The Merrimack people were so well pleased with the indications that a pumping test seemed unnecessary. We half believed this ourselves, but did not think best to take the chances, so we started pumping from about eight wells something like 100 000 gallons in twenty-four hours. The quality and quantity were both very uniform for about three days. Suddenly the water became warm, the temperature going up to about 60°, I believe. The water changed entirely in its nature and evidently came through from a river in the vicinity. The pumping test may not prove that the supply is going to hold out for all time, but it does show *some* of the dangers which the underground water supplies are subject to.

Mr. Johnson* (*by letter*). — Mr. Hazen has apparently failed to note what I tried to emphasize as one of the most important parts of the pumping test, namely, the observation of the height of the ground water in the vicinity during and after the test. The cases cited by Mr. Hazen are excellent illustrations of the value of the properly conducted pumping test. If such a test had been made in these instances and the data secured, which is necessary for the proper interpretation of the test, what actually happened could have been foretold with accuracy.

* Author's closure.

If water is stored in a pocket of porous material beneath the surface of the ground with little inflow into it, there should be no difficulty in determining this fact by lowering the level of the water in the pocket and observing the recovery of the water. Several such cases were referred to in the original paper, and the diagrams illustrating them were shown on the screen but were not reproduced in the JOURNAL.

In the case of water being drawn from a salt-water source, observations of the ground water level would undoubtedly have shown that water was being drawn from the direction of the salt water, and it might reasonably have been expected, if the ground water level was held below the sea level, that ultimately some salt would be drawn into the wells.

The cases cited, instead of showing the weakness of the pumping test, show most conclusively the value of such a test, for in all of the cases the failure of the supply might have been predicted.

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BOSTON SOCIETY OF CIVIL ENGINEERS
FOUNDED 1848

PROCEEDINGS

NOTICE OF REGULAR MEETING.

A REGULAR meeting of the Boston Society of Civil Engineers will be held on

WEDNESDAY, OCTOBER 20, 1915,

at 7.45 o'clock P.M., in CHIPMAN HALL, TREMONT TEMPLE, BOSTON.

Mr. William S. Johnson, Sanitary and Hydraulic Engineer, will read a paper entitled, "The Water Supply of Salem, Mass." Lantern slides will be used to illustrate the paper.

S. E. TINKHAM, *Secretary.*

PAPERS IN THIS NUMBER.

"The Federal Valuation of the Boston and Maine Railroad," F. C. Shepherd. (To be presented November 17, 1915.)
Memoirs of Deceased Members.

Contributors are hereby notified that proof will not be submitted to them for examination unless requested before the 10th of the month preceding the month of publication.

MINUTES OF MEETINGS.

Boston, Mass., September 15, 1915. — A regular meeting of the Boston Society of Civil Engineers was held this evening at Chipman Hall, Tremont Temple, and was called to order at 8 o'clock by the President, Charles R. Gow. There were 35 members and visitors present.

By vote the reading of the record of the June meeting was waived, and the record as printed in the September Journal was approved.

The Secretary presented the reports of committees appointed to prepare memoirs as follows: Memoir of Benjamin G. Fogg, committee, Messrs. Leslie H. Allen and J. Arthur Garrod; Memoir of Isaac Rich, committee, Messrs. George T. Sampson, Frank B. Rowell and Theodore P. Perkins; and memoir of Past President Alexis H. French, committee, Messrs. Henry F. Bryant and Edward W. Howe. By vote the several memoirs were accepted and ordered to be printed in the Journal.

The Secretary reported the election to membership of Messrs. Madison Mott Cannon, Frederic Elwin Everett, Samuel H. Pitcher and Edward Owen Strong in the grade of member.

The President announced the death of Past President Dexter Brackett, which occurred on August 26, 1915. By vote the President was requested to appoint a committee to prepare a memoir. The President has appointed as that committee, Messrs. Frederic P. Stearns and Charles W. Sherman.

The President then introduced Mr. M. J. Lorente, civil engineer, who read a paper entitled, "Some Special Methods of Reinforced Concrete Design." The paper was printed in the September, 1915, number of the Journal. The paper was discussed in a written paper prepared by Mr. W. W. Clifford and C. H. Mangold, and in a communication from Mr. J. R. Worcester, which was read by the Secretary. Mr. Hiram B. Andrews also read a discussion prepared by himself. Brief verbal discussions were offered by Mr. John R. Nichols and by the author of the paper.

Adjourned.

S. E. Tinkham, *Secretary.*

APPLICATIONS FOR MEMBERSHIP.

[October 5, 1915.]

THE By-Laws provide that the Board of Government shall consider applications for membership with reference to the eligibility of each candidate for admission and shall determine the proper grade of membership to which he is entitled.

The Board must depend largely upon the members of the Society for the information which will enable it to arrive at a just conclusion. Every member is therefore urged to communicate promptly any facts in relation to the personal character or professional reputation and experience of the candidates which will assist the Board in its consideration. Communications relating to applicants are considered by the Board as strictly confidential.

The fact that applicants give the names of certain members as reference does not necessarily mean that such members endorse the candidate.

The Board of Government will not consider applications until the expiration of twenty (20) days from the date given.

BURLEIGH, WILLARD GILE, Waverley, Mass. (Age 21, b. Malden, Mass.) Received technical education in Malden High School, scientific course, 1913, and from buildings course at Lowell Inst., 1915. From July, 1912, to Dec., 1914, time, stock and cost data clerk, computer, etc., with H. P. Converse & Co.; from April, 1915, to date, with B. & A. R. R., office of assistant valuation engineer, as chainman and rodman. Refers to W. M. Bailey, E. P. Bliss, H. W. Hayward, W. H. Lawrence and C. E. Morrow.

KENDALL, THEODORE REED, Boston, Mass. (Age 25, b. Boston, Mass.) Received degree of S.B. from Harvard College, 1912, and degree of M.C.E. from Harvard Graduate School of Applied Science, 1914. Is temporarily employed by Prof. George C. Whipple. Refers to G. S. Deming, H. J. Hughes, L. J. Johnson, J. R. Nichols, G. F. Swain and G. C. Whipple.

NASH, SAMUEL AUBIN, Brookline, Mass. (Age 32, b. Brookline, Mass.) Student for two years at Mass. Inst. of Technology and graduate of Lowell Inst., 1908. From 1909 to 1911, with the N. Y. C. & St. L. R. R., Cleveland, Ohio, as chainman, rodman, etc.; from 1911 to 1912, concrete inspector with Tuscaloosa Mineral R. R., Tuscaloosa, Ala.; from 1912 to date, inspector for Engrg. Dept., town of Brookline; during this time has also served as inspector of building construction for Swift & Co., Syracuse, N. Y., and instrumentman for Metcalf & Eddy, Hopedale. Refers to H. P. Eddy, F. A. Leavitt, H. A. Varney and J. P. Wentworth.

STENBERG, THORNTON RICE, Worcester, Mass. (Age 20, b. Worcester, Mass.) Junior at Worcester Polytechnic Institute. Refers to Frederic Bonnet, Jr., B. A. Gibson, I. N. Hollis, H. C. Ives, E. H. Rockwell and G. C. Whipple.

LIST OF MEMBERS.

ADDITIONS.

BRYANT, CHAUNCEY D. .... 189 Bellevue St., Newton, Mass.
DEVINE, WALTER A. .... Town Hall, Brookline, Mass.

CHANGES IN ADDRESS.

ALBEE, EDWARD E. .... 130 Melrose St., Melrose Highlands, Mass.
COLLINS, HARRY B. .... 26 Elm St., Brookline, Mass.
HAYWARD, EDWIN D. .... 506 So. Indiana St., Greencastle, Ind.
LARNED, EDWARD S. .... Framingham, Mass.
MAIN, CHARLES R. .... 201 Devonshire St., Boston, Mass.
MURPHY, EDWARD T. .... 38 Hancock St., Boston, Mass.
NEGUS, ARTHUR I. .... Box 646, Cincinnati, Ohio.
OLIN, EDWIN P. .... 439 Albany St., Boston, Mass.
ROBINSON, ASHLEY Q. .... 41 Highland St., West Newton, Mass.
SANDO, WILL J. .... 1137 Wells Building, Milwaukee, Wis.
SIMONS, GEORGE W., Jr. .... 1075 Boylston St., Suite 7, Boston, Mass.
SKINNER, FENWICK F. ... 21 Park Row, Park Row Building, New York, N. Y.
TURNER, CHARLES C. .... 25 Beacon St., Portland, Me.

EMPLOYMENT BUREAU.

THE Board of Government maintains an employment bureau for the Society, to be a medium for securing positions for its members and applicants for membership, and also for furnishing employees to members and others desiring men capable of filling responsible positions.

At the Society room two lists are kept on file, one of *positions available* and the other of *men available*, giving in each case detailed information in relation thereto.

MEN AVAILABLE.

328. Age 32. Received technical education at Lowell Inst. Has had seven years' experience in mechanical engineering, including machine

design and power plant and electrical work; two years' experience in railroad work; eight months on reinforced concrete; and two years as salesman. Desires position on reinforced concrete detailing or as salesman. Salary desired, $18 per week.

329. Age 23. Graduate of Mass. Inst. of Technology, 1914, civil engineering course. Experience consists of four months as building inspector with American Tel. & Tel. Co., and fourteen months with U. S. Coast and Geodetic Survey on hydrography, leveling, plotting, etc. Desires position with railroad contractor or consulting engineer. Salary desired, $75 per month.

330. Age 20. High school education. Has had some experience as rodman, timekeeper and cost data clerk. Desires position as rodman or timekeeper. Salary desired, $12 per week.

LIBRARY NOTES.

Recent Additions to the Library.

U. S. Government Reports.

Anticlinal Structure in Parts of Cotton and Jefferson Counties, Oklahoma. Carroll H. Wegemann.

Production of Barytes in 1914. James M. Hill.

Production of Chromic Iron Ore in 1914. J. S. Diller.

Construction and Maintenance of Roads and Bridges, July 1, 1913, to December 31, 1914.

Contributions to Economic Geology, 1913: Part II.—Mineral Fuels.

Eocene Glacial Deposits in Southwestern Colorado. Wallace W. Atwood.

Fauna of Batesville Sandstone of Northern Arkansas. George H. Girty.

Production of Fuller's Earth in 1914. Jefferson Middleton.

Fuel Briquetting in 1914. Edward W. Parker.

Geology and Mineral Deposits of National Mining District, Nevada. Waldemar Lindgren.

Geology and Mineral Resources of Kenai Penisular, Alaska. G. C. Martin, B. L. Johnson and U. S. Grant.

Life History of Shortleaf Pine. Wilbur R. Mattoon.

Production of Mica in 1914. Douglas B. Sterrett.

Potash Salts, 1914. W. C. Phalen.

Production of Phosphate Rock in 1914. W. C. Phalen.

Relation of Cretaceous Formations to Rocky Mountains in Colorado and New Mexico. Willis T. Lee.

Recovery of Secondary Metals in 1914. J. P. Dunlop.

Results of Spirit Leveling in Iowa, 1896 to 1913, inclusive. R. B. Marshall.

Production of Talc and Soapstone in 1914. J. S. Diller.

(The) Use Book: Manual for Users of National Forests.

Wire-drag Work on Atlantic Coast. N. H. Heck and J. H. Hawley.

County Reports.

Essex County, N. J. Report of Olmsted Brothers on Proposed Parkway System. Gift of J. C. Olmsted.

Municipal Reports.

Chicago, Ill. Report to Real Estate Board on Disposal of Sewage and Protection of Water Supply. George A. Soper, John D. Watson and Arthur J. Martin.

Erie, Pa. Annual Report of Commissioners of Water Works for 1914.

Miscellaneous.

American Society for Testing Materials: Year-Book for 1915.

Berger Mfg. Co.: Concrete Reinforcing and Furring Plates.

Builders Iron Foundry: (The) Venturi Meter.

Canada, Department of Mines: Report on Salt Deposits of Canada and Salt Industry; L. Heber Cole: Results of Investigation of Six Lignite Samples Obtained from Province of Alberta; B. F. Haanel and John Blizard.

Institution of Civil Engineers (London): Name-index to Volumes LIX–CXVIII, Minutes of Proceedings.

Lea-Courtenay Co.: Centrifugal Pumps.

Municipal Engineers of City of New York: Proceedings for 1914.

National Board of Fire Underwriters: Regulations for Installation of Automatic and Open Sprinkler Equipments, 1915; Regulations for Installation of Blower Systems, 1915.

Railway Library and Statistics for 1914. Slason Thompson, Ed.

Second Pan-American Scientific Congress, to be held in Washington, December 27, 1915–January 8, 1916: Preliminary Program.

Water Works and Other Engineering Features of New York: Compiled for 34th Annual Convention of New England Water Works Association.

LIBRARY COMMITTEE.

NEW ENGINEERING WORK.

(Under this head a brief description of new engineering work contemplated or under construction will be presented each month. Engineers and contractors are requested to send descriptions of their work to the Secretary, 715 Tremont Temple, Boston, before 1st of each month.)

Commonwealth of Massachusetts.—METROPOLITAN WATER AND SEWERAGE BOARD. — *Water Works.* — The work of laying about 14 370 linear feet of 60-in. cast-iron pipe in Commonwealth Ave. between Prince St. and the Charles River in Newton is about 43 per cent. completed under contracts with Andrew M. Cusack, of Boston, and Charles A. Kelley, of Somerville.

The work on the granite masonry tower which is to enclose the new steel tank on Bellevue Hill West Roxbury, is about 75 per cent. completed, under contract with John Cashman & Sons Co., of Boston.

Sewerage Works. — Work is in progress on Sections 105 and 106 of the Wellesley extension, and Sections 103 and 104 will be started shortly. It is also expected that the Deer Island outfall extension and the Malden River siphon will be constructed soon.

METROPOLITAN PARK COMMISSION. — *Charles River Reservation.* — Plans and specifications have been prepared, and it is expected to call for bids in the near future for bridge over the Charles River at North Beacon St., Boston and Watertown.

Plans and specifications are being prepared for bridge over the Charles River at Commonwealth Ave., between Newton and Weston.

Work of grading, surfacing and other work from Charlesbank Road to Brooks St., Newton and Boston, is in progress. Rowe Contracting Co., contractor.

Plans and specifications have been prepared and bids received for excavating channel of Charles River from Elm St. to Bleachery Dam, Waltham.

Furnace Brook Parkway. — Work of constructing parkway extension from Quincy Shore Reservation to Hancock St. is in progress. John Cashman & Sons Co., contractors.

Work of building reinforced concrete girder bridge across Blacks Creek, for Furnace Brook Parkway Extension, is in progress. Hugh Nawn Contracting Co., contractors.

Mystic Valley Parkway. — Work of excavating and dredging the channel of Aberjona River from Boston & Maine Railroad to Waterfield St. is in progress. Coleman Brothers, contractors.

Revere Beach Reservation. — Work of building reinforced-concrete shore protection of the bleacher form at Revere Beach Reservation is in progress. Coleman Brothers, contractors.

Directors of the Port of Boston. — Contracts have been awarded for dredging the channels specified below.

Location.	Length. Ft.	Width. Ft.	Depth at M. L. W. Ft.	Estimated Quantity. Cu. Yds.
Squantum & Wollaston Yacht Clubs,	4 600	70	8	96 500
Lawrence & Wiggin Wharf in Mystic River	400	150	30	31 000
Malden Bridge in Mystic River . . .	1 150	150	10	37 300
Pleasant Park Yacht Club, Winthrop .	120	100	6	15 000
Orient Heights Yacht Club	1 100	30 to 100	6	15 700
Wessagussett Yacht Club, North Weymouth	260	100	6	4 750

Boston Transit Commission. — *Dorchester Tunnel.* — Section E includes two single-track circular tunnels, which will extend from near the junction of Summer St. and Dorchester Ave. under

the Fort Point Channel and private property to a point near Dorchester Ave. between West First and West Second Sts., South Boston. The length of this section is about 3 200 ft., of which about 2 160 ft. is directly under the channel. Work is being carried on from a shaft in West First St., from which two circular shields are being driven northerly toward Summer St. under compressed air. The shield for the easterly tunnel, which was started first, is now under the channel and the westerly tunnel shield is under the coal storage yards east of Dorchester Ave.

Section H is located in Dorchester Ave. between Old Colony Ave. and Woodward St., and is about 2 200 ft. long. The structure is to be mainly of reinforced concrete, and consists of a single-span double-track tunnel to be built by the cut-and-cover method. The work also includes a pump well, an emergency exit, and sewer changes. Excavation at the southerly end has been finished for a distance of about 1 000 ft. and at the northerly end of the section near Old Colony Ave. for a length of about 500 ft. The tunnel has been completed at the southerly end for about 700 ft. and at the northerly end for about 300 ft. The T. A. Gillespie Co. is the contractor. The work under this contract was extended September 16 a distance of 420 ft. further to the south towards Andrews Sq., and operations on the extension will soon be started.

East Boston Tunnel Extension. — The finish of the stations of the East Boston Tunnel Extension is nearly completed. Work is progressing on the coverings over the stairways at Scollay Sq. near the head of Hanover St.

The final restoration of the pavement along the route of the East Boston Tunnel Extension is in progress under a contract with Coleman Brothers. The work includes granite block paving on a concrete base in Cambridge St., Bowdoin Sq., Green St., Court St., and Scollay Sq.

Boylston Street Subway. — Boylston St. between Arlington St. and Carver St. is being repaved with wood blocks on a concrete base. In connection with this work the Boston Elevated Railway Co. is relaying the old tracks and laying additional tracks in Boylston St. between Arlington St. and Park Sq.

They are also constructing in Boylston St. at the head of the subway incline, landing platforms for both inbound and outbound cars.

City of Boston. — PUBLIC WORKS DEPARTMENT, HIGHWAY DIVISION, PAVING SERVICE. — Work is in progress on the following streets:

St. Williams St.	from Dorchester Ave. to Auckland St.	Concrete base.
Orleans St.	from Gove St. to Porter St.	Concrete base.
Bayswater St.	from Saratoga St. to Austin Ave.	Bituminous macadam.
Ardent St.	from Colberg Ave. to Belgrade Ave.	Concrete base.
Chapin Ave.	from Mt. Vernon St. to Preston Rd.	Bituminous macadam.
Pelton St.	from Park St. to the Parkway.	Bituminous macadam.
Augustus Ave.	from Poplar St. to Clarendon St.	Bituminous macadam.
Schiller Rd.	from Rockland St. to the Dedham line.	Bituminous macadam.
Birch St.	from Penfield St. to Dudley Ave.	Bitulithic pavement.
Poplar St.	from Sycamore St. to Brown Ave.	Artificial stone sidewalks.
Prince St.	from Pond St. to the Arborway.	Asphalt pavement.
Dane St.	from Holbrook St. to Orchard St.	Asphalt pavement.
Haslet St.	from Amherst St. to Metcalf St.	Bituminous macadam.
Crandall St.	from Augustus Ave. to Hillside St.	Bituminous macadam.
Dunlap St.	from Washington St. to Whitfield St.	Concrete base.
Helen St.	from Bernard St. to Talbot Ave.	Concrete base.
Lyford St.	from Woodrow Ave. to Franklin Field.	Bituminous macadam.
Oakland St.	from River St. to Rockdale St.	Bituminous macadam.
Peacevale Rd.	from Norfolk St. to Dunbar Ave.	Asphalt pavement.
Leslie St.	from Dix St. to Centre St.	Asphalt pavement.
Blue Hill Ave.	from Talbot Ave. to Morton St.	Artificial stone sidewalks.
Brunswick St.	from Blue Hill Ave. to Normandy St.	Concrete base.
Highland St.	from Hawthorne St. 130 southerly.	Artificial stone sidewalks.
Lucas St.	from Washington St. to Shawmut Ave.	Concrete base.
Public Alley 908	from Mass. Ave. to Marlboro St.	Brick block pavement.
Public Alley 809	from Batavia St. to Gainsboro St.	Hassam block pavement.
Public Alley 810	from Public Alley 809 to 811.	Hassam block pavement.
Public Alley 811	from Batavia St. to Gainsboro St.	Hassam block pavement.

The Fore River Shipbuilding Co., Quincy, Mass., has the following work in progress:

U. S. Battleship *Nevada*.

Ten submarine boats.

U. S. Torpedo Boat Destroyers *Tucker* and Nos. *63* and *64*.

Two oil-tank steamers.

Two molasses steamers and a cargo vessel for the Cuba Distillery Co.

Two freight steamers.

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BOSTON SOCIETY OF CIVIL ENGINEERS
FOUNDED 1848

PAPERS AND DISCUSSIONS

This Society is not responsible for any statement made or opinion expressed in its publications

THE FEDERAL VALUATION OF THE BOSTON AND MAINE RAILROAD.

By F. C. Shepherd,* Member Boston Society of Civil Engineers.

(To be presented November 17, 1915.)

The Act to Regulate Commerce became a law February 4, 1887. This law was amended March 1, 1913, by an Act which added a new section, to be known as Section 19a, which is the so-called and much discussed "Federal Valuation Act."

A careful study of this Act brings out the following:

First. That the Interstate Commerce Commission is required to investigate, ascertain and report the value of all the property owned or used by every common carrier subject to the Act to Regulate Commerce, and that the Commission is given full authority to employ such experts, assistants and examiners as shall be necessary in the carrying out of the valuation work.

Second. That the Commission is to make an inventory which shall list the property of every common carrier in detail and show the value thereof, and shall classify the physical property as nearly as practicable in conformity with the Classification of Expenditures for Road and Equipment as prescribed by the Commission.

Note. This paper is issued in advance of the date set for its presentation. Discussion is invited, to be received by Edward C. Sherman, Editor, 6 Beacon Street, Boston, before January 10, 1916, for publication in a subsequent number of the Journal.

* Valuation Engineer, B. & M. R. R.

Third. That the Commission is to ascertain and report in detail as to each piece of property owned or used by every common carrier for its purposes as a common carrier, the original cost to date, the cost of reproduction new and the cost of reproduction less depreciation, and is to make an analysis of the methods by which these several costs are obtained and the reasons for their differences, if any.

Fourth. That the Commission is to ascertain and report separately other values and elements of value, if any, of the property of every common carrier.

Fifth. That the Commission is to investigate and report in detail and separately from improvements the original cost of all lands, rights of way and terminals owned or used for the purposes of a common carrier, ascertained as of the time of dedication to public use, the present value of the same and, separately, the original and present cost of condemnation and damages or of purchase in excess of such original cost or present value.

Sixth. That the Commission is to investigate and report separately the property held for purposes other than those of a common carrier and the original cost and present value of the same.

Seventh. That the Commission is to investigate and report upon the history and organization of the present and of any previous corporation operating such property; upon any increases or decreases of stocks, bonds or other securities in any reorganization; upon moneys received by any such corporation by reason of any issues of stocks, bonds and other securities; upon the syndicating, banking and other financial arrangements under which such issues were made, and the expense thereof; and upon the net and gross earnings of any such corporations. It is also to ascertain and report in such detail as may be determined by the Commission upon the expenditures of all moneys and the purposes for which they were expended.

Eighth. That the Commission is to ascertain and report the amount and value of any aid, gift, grant of right of way or donation made to every common carrier, or to any previous corporation operating such property, by the Government of the

United States or by any state, county or municipal government, or by individuals, associations or corporations; that it is also to ascertain and report the grants of land to every common carrier or any previous corporation operating such property, by the Government of the United States, or by any state, county or municipal government, and the amount of money derived from the sale of any portion of such grants and the value of the unsold portion thereof at the time acquired and at the present time; also the amount and value of any concession and allowance made by every common carrier to the Government of the United States or to any state, county or municipal government in consideration of such aid, gift, grant or donation.

Ninth. That the investigation shall show the value of the property of every common carrier as a whole and separately in each of the several states and territories and the District of Columbia.

Tenth. That the Commission is to report results to Congress at the beginning of each regular session until all the work is completed.

Eleventh. That every common carrier is obligated to furnish to the Commission any maps, profiles, contracts, documents, records, etc., which may be asked for, shall grant to the agents of the Commission free access to all its property and records, and shall fully coöperate with and aid the Commission in all particulars.

Twelfth. That upon the completion of the valuation the Commission shall thereafter keep itself informed of all extensions, improvements or other changes in the condition and value of the property of every common carrier, shall ascertain the value thereof and shall from time to time revise and correct its valuation.

It will be seen from the above that this is not a mere physical valuation, but that it is a valuation in detail of all property owned or used by every common carrier, subject to the Act to regulate commerce.

Such common carriers include all corporations or persons engaged in the transportation of oil or other commodities except water and except natural or artificial gas, by means of pipe lines

or partly by pipe lines and partly by railroad; all telegraph, telephone and cable companies performing interstate business; and, of course, every railroad company whose business extends from one state into another.

There have been many discussions as to the reasons for this valuation Act and what the probable results would be. Just what was in the mind of Congress is, of course, not definite, but it appears from various recommendations which have been made to Congress from time to time by the Interstate Commerce Commission, and which were doubtless the controlling force in securing the enactment of this Act, that the valuation was essential —

(*a*) To obtain a trustworthy estimate of the relation existing between the present worth of railroad property and its cost to its proprietors;

(*b*) In determining whether rates as fixed by the Government are confiscatory;

(*c*) In connection with railway taxation;

(*d*) In the ascertainment of a proper depreciation reserve;

(*e*) In testing the accuracy of the balance sheets of the carriers;

(*f*) To the organization of railway statistics in general;

(*g*) In determining whether the railroads are under or over capitalized.

The valuation is a national valuation, but the law requires it to be made by state lines. When completed there will be not only a federal valuation of all interstate railroads and other common carriers, but a state valuation, which will probably supersede and supplant every other state valuation which can be made.

There is no more important practical question before the people of this country to-day than the treatment which should be accorded to their transportation facilities by rail. The valuation now being made is one of the most important factors in the decision of that question.

We have, first of all, the fundamental primary question as to whether the Government will take over these agencies of transportation, or whether it will suffer them to be conducted

for private profit. At the basis of this question lies the further question, of what is the value of these properties, and it is not supposed that the people of the country will ever come seriously to the discussion of government ownership until they first know what is the value of the railroads and what is the relation of that value to their capitalization.

If the railroads are to be left in private hands we have the still more important question of what treatment shall be accorded to the private capital which has been invested in them; for that treatment must be such as will not only do justice to the property which is there, but such that will attract other capital to that same sort of investment. The federal valuation is bound to be the basis of the determination of this question, and it will be the basis of the rates fixed by the Interstate Commerce Commission, and the main basis of the rates which will be fixed by the various states.

The magnitude of the work as regards railroads can best be appreciated with the knowledge of the following:

On June 30, 1913, the railroads of the United States comprised approximately 250 000 miles of line, which, with double tracks, yards and sidings, approximated 376 000 miles of track. The capital securities of these companies which were outstanding in the hands of the public at that time amounted to approximately $15 000 000 000, of which, roughly speaking, 60 per cent. was bonds and other forms of indebtedness, and 40 per cent. stock, the latter being owned by over 620 000 stockholders. The number of employees was 1 815 000, their compensation aggregating $1 373 000 000. During this same year the railroads paid in taxes over $120 000 000.

For the undertaking of this immense work the Interstate Commerce Commission has organized a Division of Valuation, under the charge of Mr. Charles A. Prouty as director. Mr. Prouty had been a member of the Interstate Commerce Commission for many years and resigned from the Commission to take over this work. The director has, to assist him in carrying on the valuation work, besides counsel, an advisory board, an engineering board, a supervisor of land appraisals, a supervisor of accounts and a cost bureau.

For the purposes of the valuation the United States has been divided into five districts.

The Engineering Board is composed of five engineers. While the Board as a whole has direction of all the engineering features connected with the valuation, each member is directly in charge of one of the five districts. This Board outlines all the methods to be pursued and details to be carried out looking towards the obtaining of the detailed lists of the physical property other than lands, as noted in the second paragraph of the study of the Act. The Board will also complete for the physical items the cost of reproduction new and the cost of reproduction less depreciation.

The Supervisor of Land Appraisals has charge of the ascertaining of the present value of all railroad lands. He is assisted by five valuation attorneys, each attorney being directly in charge of a district.

The Supervisor of Accounts has charge of the investigation of the history and organization of every railroad and also of all financial investigations called for in the Act, and in addition to this the working out of the original cost to date. He is assisted by five valuation accountants, each accountant being in charge of a district.

The Cost Bureau is at work making investigations and collecting data for use in preparing the unit prices which will be used by the Engineering Department, after they have made their inventory, for the working up of the cost reproduction new. In addition to making such investigations themselves, the bureau has called on the railroad for a great deal of information which will be described later on under Order No. 14.

When the Act became a law, the railroads of the United States, recognizing the magnitude of the work to be done, knowing that they were to participate and realizing that it was for the interest of all concerned to have the work done as correctly as possible and all proper facts ascertained, organized a Presidents' Conference Committee as a central body to represent all the railroads. Every railroad was invited to join this conference, and at the present time it is supported by 215 000 miles, or approximately 86 per cent. of all the railroads in the United States.

Mr. Samuel Rea, president of the Pennsylvania Railroad, is general chairman of this committee, and Mr. Thomas W. Hulme is general secretary of this and all the other committees.

For the actual work, the railroads have separated into three groups, Eastern, Western and Southern, each group having its presidents' committee.

There is also a board of counsel associated with the Presidents' Conference Committee.

To handle the various details, separate group committees were appointed, one for engineering, one in connection with lands, and one in connection with the studies of financial histories and accounts. These various committees meet both separately and together. Each engineering committee has a group office in charge of a group engineer. All these committees have been continuously at work since their inception and have accomplished a great deal in the interests of the railroads. Every feature which has come up has been thoroughly discussed by them and then in turn with the Division of Valuation representatives. They have presented a great deal of data to the Valuation Division and have taken active part in the preparation of the various orders made by the Commission, and at the same time have kept the railroads in the country continuously advised of every step which has been made towards the working out of the methods of the valuation.

In addition to this, the State Public Service and Railroad Commissions have taken an active interest in the Federal Valuation. Their national organization has followed the matter, and with special committees the states have been represented at all the conferences between the Valuation Division and the railroads, and at such meetings have taken active part in presenting their views and suggestions. In some of the actual inventory work the State Commissions are represented in the field. Undoubtedly they will ask that the railroads file with them similar records to those which are filed with the Interstate Commerce Commission, and they will, of course, take more active part as the work proceeds, looking towards the final establishment of values.

At the beginning there was considerable discussion as to just how much detail work should be done by the Commission,

and how much they should require from the railroads. The Act calls for the Commission to make an inventory of the property of each common carrier. It was finally decided by the Division of Valuation that, in order to know that the units in their inventory were correct, they should obtain these units themselves. This is being done, but the valuation work as a whole is so divided under present arrangements that the Commission and the railroads are doing about an equal amount. The parts to be done by the railroad are specified in orders made out by the Division of Valuation and issued by the Interstate Commerce Commission. The first order was issued February 1, 1914, and to date twenty have been issued. These are as follows:

Order No. 1. Specifications for maps and profiles.
Order No. 2. Abandoned property.
Order No. 3. Regulations to govern the recording and reporting of all extensions and improvements or other changes in physical property of every common carrier.
Order No. 4. Inventory of materials and supplies.
Order No. 5. Modifying and supplemental order to Order No. 1.
Order No. 6. Regulations modifying and supplementing valuation Order No. 1.
Order No. 7. Order and instructions pertaining to schedules of lands.
Order No. 8. Regulations to govern the recording and reporting of register of equipment and original cost to date of same.
Order No. 9. Order regarding transportation of employees, supplies and cars of the valuation division.
Order No. 10. Modifying and supplemental order on abandoned property.
Order No. 11. Order and instructions pertaining to an inventory of records.
Order No. 12. Order for listing industrial tracks.
Order No. 13. Order regarding inventory and schedules to be made by carriers.

Order No. 14. Order and instructions pertaining to purchases of materials, prices paid and rates of compensation paid for labor.

Order No. 15. Order and instructions pertaining to privileges given and leases made by steam railroads.

Order No. 16. Order and instructions pertaining to aids, gifts, grants and donations.

Orders Nos. 17 and 18. Order and instructions pertaining to purchases of materials, prices paid and rates of compensation paid labor pertaining to telegraph and telephone companies.

Order No. 19. Order and instructions pertaining to purchases of material, prices paid and rates of compensation paid for labor pertaining to telegraph and telephone property of railroads.

Order No. 20. Order covering corporate history of railroads.

All these orders either have specified dates on which they shall be complied with, or are so written that the director can specify the dates at his discretion. In the beginning the dates were uniform for all railroads, but modifications have been made, and where the carrier is not able to meet these dates extensions have been granted by the Division of Valuation, if they were convinced that the carrier was making a proper effort toward complying with them.

Order No. 1 obligates every steam railway carrier to file with the Commission maps and profiles of its entire system as it existed June 30, 1914, and specifies in detail just what is to be shown on each map and profile. The maps are all to be of a definite size, 23 in. x 55 in. inside the border, with a scale of 100, 200 or 400 ft. to one inch, each map to contain not more than one, two or four miles between match marks for the adjacent sheets. These maps are to be in much detail and are to show a complete survey of the railroad with all existing struc-

tures; survey stations and details of alignment are to be shown, and also each individual parcel of land which the railroad owns, with a table giving full information as to the acquisition of each parcel. All profile sheets are to be made 10 in. x 55 in. inside the border and on standard Plate A, with a scale of 1 in. equals 20 ft. vertical, and 1 in. equals 400 ft. horizontal. These profiles are to show the railway grade line with all rates of grade and changes, the original surface of the ground at the center line and all bridges, culverts and other information which may be available. It is estimated that to comply with this order the Boston and Maine Railroad will have to make about 3 000 maps and 750 profiles. Moreover, we are obligated to file all such maps and profiles with the Government on tracing cloth, either original tracings or reproductions.

Order No. 2 prescribes that each carrier shall file with the Commission complete and detailed schedules of all fixed physical property abandoned prior to June 30, 1914, together with a complete and detailed statement of claims with respect thereto. These schedules are to show the property acquisition in accordance with the investment accounts, are to give physical units of the property with the original cost of same to date of abandonment, date of abandonment and disposition and present status of abandoned property. Maps, profiles and other records may be requested by the Commission.

Order No. 3 specifies a standard form by which, beginning with the date of valuation, the carriers are to furnish each year to the Commission a complete statement of all extensions and improvements or other changes in the physical property. This is required so that the Commission will have the necessary information to revise the valuation from year to year.

Order No. 4 instructs every steam railway carrier to make as of June 30 each year an inventory of materials and supplies carried in stock.

Order No. 5 modifies the date of filing of maps called for in Order No. 1.

Order No. 6 modifies Order No. 1, in that it decreases somewhat the amount of detail to be shown on plans of any carrier having less than one hundred miles of main line and

roadway, and gross earnings of operation of less than $3 000 per mile.

Order No. 7 calls for a typewritten schedule giving full information regarding each parcel of land owned or used by the carrier. There are two forms accompanying this order, one for lands used for purposes of a common carrier, and the other for lands held for purposes other than those of a common carrier. Each parcel is to be as recorded on the maps in Order No. 1, and in addition to the acquisition records the railroads are obligated to show the area and original cost of every parcel of land which they now own.

Order No. 8 calls for a register of all equipment and a detailed statement of the original cost to date of each piece of equipment. The following kinds of equipment are classified:

1. Roadway machines.
2. Shop machinery.
3. Power plant machinery.
4. Power substation apparatus.
5. Steam locomotives.
6. Other locomotives.
7. Freight train cars.
8. Passenger train cars.
9. Motor equipment of cars.
10. Floating equipment.
11. Work equipment.
12. Miscellaneous equipment.

Accompanying the order are standard forms which are to be filled out, these forms to be typewritten in duplicate and filed with the Commission.

Order No. 9 provides for transportation of Government employees, and covers charges to be made for transporting supplies, equipment and outfit cars which these employees are using on the work.

Order No. 10 modifies the date of the filing of schedule of abandoned property called for in Order No. 2.

Order No. 11 prescribes forms on which a typewritten inventory shall be made of all principal records, documents and papers in the possession of the railroad, this covering the records of the directors and stockholders, ledgers, journals, cash books, security records, construction records, rail records, bridge records, annual reports and other miscellaneous records.

Order No. 12 prescribes a form on which the carrier shall furnish a typewritten schedule of every industrial track; that

is, each track which the carrier has not an unrestricted right to use in serving the public. This record calls for the location of the track, the length, map number, and any agreements which may be in existence in the carrier's records regarding same.

Order No. 13 gives the director authority to instruct any carrier to prepare and file a complete inventory of quantities, units and classes or kinds of property, other than that called for in Orders 7 and 8.

Order No. 14 calls for schedules showing purchases made and prices paid during the last five or ten years for practically all the various kinds of materials which are used by a railroad. It also calls for a schedule of rates of compensation to employees for the last ten years. Accompanying this order are 87 forms, each for a different kind of material, which are to be filled out by the carrier, giving complete information of purchases, freight, etc.

Order No. 15 instructs the carrier to file a summary statement, for the fiscal year ending June 30 next preceding the date fixed by the Commission as that on which the carrier's property shall be valued, of money received from other carriers for use of any property, except equipment, and money received from other than carriers for use of carrier property. It also furnished a form on which is to be shown a schedule of all leases of land claimed by the carrier to be owned for its purposes as a common carrier, with some minor exceptions.

Orders Nos. 17 and 18 apply to telegraph and telephone companies.

Order No. 19 is similar to Order No. 14, in that it requires a schedule list of all purchases made by every carrier for material which is used in connection with telegraph and telephone work. There are thirty-four forms accompanying this order, which are to be filled out on the typewriter.

Order No. 20 calls for a complete statement of all facts of every corporation, company or firm at any time connected with the railroad. This information has to show the name of every corporation, date of incorporation, date of organization, description, amount constructed, length of time actually operated, and date of beginning and date of conclusion of such operation.

It also prescribes a form for a chart which will show all this information in great detail.

The first start towards valuation work on the Boston and Maine Railroad was made in November, 1913, when the president appointed a valuation committee. This committee at first consisted of three members but was later increased to seven. At the first meeting of this committee, which was held on November 20, 1913, Mr. A. B. Corthell, chief engineer, was elected chairman, the writer appointed valuation engineer, and Mr. M. C. Bradley appointed valuation accountant.

At that time no active work had been started by the Commission and only the Engineering Board had been organized for the actual work. The Board had held quite a number of joint meetings with the Railroad Engineering Committee, working out details covering the plans to be required and the methods to be followed in obtaining physical inventory.

We first started a careful study of the history of the Boston and Maine Railroad. The present system is composed of some one hundred and seventy original corporations, the first of which was chartered in 1796. Under reorganizations, purchases and consolidations, there are now forty existing corporations, all of which are either owned, leased or controlled by the Boston and Maine.

Having the corporate ownerships as now existing we next made a study for a schedule of inventory or valuation sections. We were confronted with the fact that the valuations are to be made by state lines, and that, for our own records at least, we should make the valuation sections agree with existing corporations. We have therefore made the valuation sections as a whole by corporate ownerships, although there are some parts where the ownerships were so extensive or diversified that we have given more than one section to a corporation. At the present time we have sixty valuation sections, for each of which separate inventories and collections will be made. With all these corporations there are six common carriers under the Act, for which valuations will be made by the Commission. These are as follows:

Boston and Maine Railroad.

York Harbor and Beach Railroad Company.

The Sullivan County Railroad.

Vermont Valley Railroad.

Montpelier and Wells River Railroad.

The St. Johnsbury and Lake Champlain Railroad Company.

The second, third and fourth of this list are operated by the Boston and Maine as agents, while the last two, although controlled by the Boston and Maine, are operated independently.

On January 16, 1914, we were advised that the Boston and Maine Railroad was one of the first roads on which valuation work would start, and that actual field work would be commenced about May 1. The date fixed for the valuation of the Boston and Maine Railroad is as of June 30, 1914.

Originally, the Interstate Commerce Commission was of the opinion that all carriers in the United States should be valued as of the same date. After following the matter carefully, they decided that this could not be very well done, and consequently the various roads are being valued as of different dates.

On February 1, 1914, Order No. 1 was issued, following which our Valuation Department was organized. We first made a careful study of what plans were in existence on our entire system so as to determine which of them could be made acceptable to the Commission for filing under Order No. 1. A careful study revealed the fact that on our system of some 2 500 miles there were in existence maps, of various sizes, and mostly on a scale of 1 in. equals 100 ft., for about 1 000 miles, which it appeared could be brought up to date without complete field surveys. For the other 1 500 miles we found that complete new resurveys would have to be made.

We started in the office making tracings, in accordance with the Government regulations, from the existing maps, and to complete these maps started small parties of two men each over our lines, obtaining the data necessary to complete the plans; such as survey station points for turnouts, structures, etc., locations and dimensions of culverts, fences and buildings and other miscellaneous items, all of which would have to be placed on the maps before they could be filed with the Government.

For this work four parties of two men each, under the charge of an assistant engineer, completed the 1 000 miles in the field between February 16 and December 11. As fast as the field work was done, the information obtained was placed on the tracings in the office.

For the new survey work, parties were started in the field in February, 1914. A gradual increase in the number of parties was made until nine parties were at work, and have been continuously to date. Up to September 1, 1915, these parties had completed resurveys for 1 250 miles of line and an entire resurvey of the Boston terminal, and it is anticipated that the entire work will be done by December 1, 1915. These parties are composed of four field men and one draftsman, three parties being under the direct charge of an assistant engineer. The field draftsman travels continuously with the survey party, and completes and forwards to the main office a plan which shows all existing features, survey stations, offsets and other information, or a complete detailed resurvey of our line. These plans are inked in on mounted paper in rolls containing approximately seven miles on a scale of 100 ft. to the inch.

The speed of these parties varies with the character of the line on which they are working, there being some locations where on account of congestion, number of tracks, etc., they will not cover more than half a mile a week, while on other lines, where the conditions are much different, we have had some parties cover seven or eight miles a week. The average throughout is approximately three miles a week for each party.

All these parties find their own subsistence, using for the most part passenger or freight trains to go back and forth from where they are living to the place at which they are working. We have, however, in some instances, used motor cars, and find that where such a car has been used we have increased our work at least two miles a week, this condition, of course, applying to lines where the railroad stations are few and far apart.

On this work we are using duplicate field note books, by which a carbon copy is obtained of all the work. By doing this the draftsman always has a copy of the field notes the day after they are taken. We find that by keeping the field plans in close

touch with the field survey work we reduce corrections and the picking up of omissions to a minimum.

As fast as the field plans are received in the main office they are laid out for the Government sheets and the tracings made. A draftsman in the office can complete such tracings at the rate of two to three a day. For all the tracings we purchase the cloth cut to size, with the border lines printed thereon. For the title work we are using a Golding printing press. In the press, instead of type, we are using plates which are reproductions of the lettering of one of our draftsmen. With the press and the plates we are able to put titles on our maps at a cost of about one and one-half cents each, and at the rate of about two hundred in four hours.

Where we have made resurveys we are painting the rail at every 100-ft. station, and noting the station at 500 or 1 000 ft. intervals, this being done to aid in the taking of profiles where necessary, and also for the assistance of the Government engineers in their chaining. Up to the present time we have made no start on profile work. It is hoped that instead of the profiles, as called for in Order No. 1, we can substitute our regular track charts, which, while on a much larger scale, give a more comprehensive idea of the rise and fall of the grades, and which we think would be much more suitable for use in working out valuation than that called for by the map order.

Our next step is the working up of the land lines and land records called for in Order No. 1, and it is this work which we find is the most difficult and takes the most time. At the start we found that there was practically no part of our system on which the land records were complete, and that there was a large proportion of our system on which no land maps were in existence. We have therefore found it necessary to reproduce on our plans all the land lines for the entire system. It can readily be seen what it means when it is realized that the purchase of the lands covers a period from about 1830 to date, and that there are about 25 000 land parcels to be located. It can also be realized that, as many of the original corporations are non-existent and have passed through so many hands during the different reorganizations, many records have been lost.

While our men in the office use the deeds which are in the possession of the railroad, many deeds are missing, and our Land Commissioner has for over a year had his assistants going to every registry point in New England and part of New York State obtaining a record of every deed in the name of any railroad which has ever been a part of our system. After checking this record against the deeds we have, abstracts are then made of the missing ones. Beyond this the Commissioner is obtaining copies of all county commissioners' awards and all locations as filed for all the railroads. We find, even with all this information, that there are many places where we can get no records of ownership of parts of our right of way. At these points, of course, we will be obliged to fall back on the fact that the railroad is there and in possession. Such records will undoubtedly be accepted by the Commission.

After making up the plans in accordance with Order No. 1 we are starting on Order No. 7. For this order we are obliged to show on the form called for, besides the information above shown in the plan, the areas and the considerations shown in the deed for all the land parcels. These forms are then handed to the valuation accountant, who will work up the information regarding the original cost of every parcel. This means a tremendous amount of work, as it will entail going over all the original records which can be found and obtaining from these records information regarding every voucher by which payment was made for every parcel of land. Further than this, we are to find, and of course it is to our advantage also, any information possible regarding expense incurred in each acquisition. It will, of course, be absolutely impossible for us to find such information in many instances. Many of the old records are gone, or lost by fire.

The physical inventory is obtained from an actual survey of conditions as of to-day. It is perfectly obvious that many conditions which existed at the time the railroads were built cannot be shown or found to-day and that in such an inventory the railroads therefore would lose many items which should be used in the reproduction cost. This question has faced the railroads since they first started on this work. In order to

reduce such a loss as much as possible we first issued the following circular letter:

BOSTON AND MAINE RAILROAD.

BOSTON, MASS., February 25, 1914.

To All Concerned:

In connection with the Valuation of the Boston and Maine Railroad, which is about to be started by the Government, it will greatly aid the Railroad, and perhaps be of considerable ultimate gain, if any person having any information regarding note books, plans, or any other records which are not on file in the various head offices, or if any of the older employees can give any specific information regarding difficulties met with during the construction of the various parts of the road, or any conditions which required unusual expense, such information will be gladly received and greatly appreciated, if reported to Mr. F. C. Shepherd, valuation engineer, Boston, Mass.

All books, papers or documents relating to the financial or corporate history of the various roads now in the system, should be reported to Mr. M. C. Bradley, assistant to the general solicitor, Boston, Mass.

It should be understood that any information requested by parties in the Valuation Department should be freely given.

VALUATION COMMITTEE,
A. B. CORTHELL, *Chairman.*
E. J. RICH.
S. H. MCINTOSH.

This circular was sent all over our system and posted in all offices and yards with the hope that it would reach the eye of some one who had in his possession old records or information, or who could tell us where they thought such information could be obtained. The responses from this circular were quite gratifying. From it we have located many old records, plans and note books which were not known to be in existence. We have also received a great deal of information by letter. To handle this feature of the work we organized a small squad for hidden research. It was the duty of some of the members of this squad to interview those from whom letters had been received, and finally we started some of them walking the line, interviewing everybody who had any knowledge of any part of the railroad. All the information which was obtained was placed on index cards. Moreover, all the note books and plans

that we could find were collected. In addition to this the valuation accountant has had a squad of men at work getting for us all information regarding quantities on the many large improvements and grade-crossing separations made since the railroad was originally constructed. All the information so obtained is furnished to the pilots for their use as they go over the various parts of our system.

To assist in describing the inventory features, I have divided them into three departments, engineering, lands and accounts.

Engineering.

As noted above, the engineering features for the Commission are handled by the Engineering Board, one member of which is in charge of each district. This member has under him a district engineer, who in turn has under him senior field engineers who have direct charge of the inventory of track and roadway, a senior structural engineer who has charge of the inventory of bridges for the entire district, a senior architect who has charge of the inventory of all buildings for the district, a senior signal engineer who has charge of the inventory of all signals and interlocking in the district, a senior telegraph engineer who has charge of all inventory of telegraph and telephone lines in the district, a senior mechanical engineer who has charge of the inventory of all equipment and machinery in the district, and a senior electrical engineer who has charge of the inventory of all electrical equipment in the district. For the guidance of the men actually in charge of the work, printed instructions have been issued by the Engineering Board covering these various branches, copies of which are given to the railroads for their information.

The first Government track and roadway party started on the Boston and Maine Railroad on April 29, 1914. Other parties were added, so that during the year 1914 there were five such parties at work. The work here was suspended during the winter months and these parties transferred to the South. They returned here again in April, and during this year six parties have been at work. Up to the present time, 1 900 miles

have been covered by these parties, and it is anticipated that all the track and roadway inventory work will be completed on the Boston and Maine by December 15.

All these parties are under the charge of a senior field engineer, with headquarters in Boston. Each party is under the charge of an assistant engineer. These parties usually comprise nine men, — the assistant engineer, three cross-section-men, three recorders and two computers. The cross-section party is taking cross sections of our roadbed so as to obtain all the grading quantities which go to make up the present cuts and fills. The number of sections taken depends, of course, on the conditions as actually found. Practically all of the cross-section work has been done with a Lock level and a tape, although there are times when a "Y" level has been used, and some experiments have been made with special cross-section instruments. As yet these instruments have not been generally adopted, although in one of the districts the so-called "Beeman arc" has been used. The cross sections when taken are plotted directly into note books in the field, and usually on a scale of 1 in. equals 10 ft. On each section is shown the distance out and the distance down, with the center of the track and the base of the rail being assumed as zero; for all changes in the section the original ground surface at the base of fills or edge of cuts is noted. The original surface where removed is plotted by judgment. No elevations are taken. When the sections are being made, the classification is shown on them. Each day the cross-section notes are turned over to a computer, who works up the area of each section by use of a planimeter, and transfers the areas to a quantity diagram. This, in reality, is a mass profile, from which the quantities of each cut and fill can be obtained directly by planimeter. The diagrams when finished are sent to Washington, where they will be used in connection with the necessary computations for overhaul. Ballast depths and sections are taken for each cut or fill and deducted or added to the cross sections, depending on whether the cross section is an embankment or a cut. Ballast depths are found by digging, and for this the railroad furnishes the labor.

The recording party chains the line and makes a complete

inventory of features other than grading and ballast. The weights of the rails are noted; the ties, rail braces, tie plates and anti-creepers are counted in two 600-ft. blocks for each mile, from which an average is obtained for the entire mile; all culverts are measured and dimensions noted; all information at turnouts is obtained, with a notation for each part, such as the switch, frog, guard rail, etc.; a record is made of all signs and fences; bridges up to 16 ft. span are inventoried; the result being a complete inventory of all the parts which go to make up the track and roadway, outside of ballast and grading. All computations and collections of this information are made in the office by a computer, and for each mile or track plan as made by us. The computers in the office collect all this by accounts and work up all quantities.

When the work was first started the ordinary type of note book was used, with a complete running sketch being made of the entire road, and from this the computations were made. As the work proceeded, however, developments were made of a type system, by which the various items are typed by letter or number. With the aid of these and special field forms, much better progress is made and a much better inventory obtained. At the present time these field parties average about $2\frac{1}{2}$ miles a week.

With each party we have placed an engineer, who is called a "pilot," and office computers. It is the duty of the pilot to represent the railroad and to coöperate with the Government engineer, and to point out all unusual conditions or hidden quantities of which we may have record, these records usually being on the cards which were noted above. He agrees with the field engineer on the grading classification and the depth of ballast. The computers are at work with the Government computers checking their computations.

At first these parties found their own living along the line where they were working. The computations were made in whatever rooms we could furnish, or in the rooms in which the men were boarding. To keep the work better centered and have a place where all the men could work, especially in rainy weather, we are now furnishing field office cars. For this work we have

taken an old passenger car or a caboose car and fitted it up with long tables for the men to work on. At the present time the Government field men, instead of living on the country, are using their own cars. These are Pullman cars which have been purchased and rebuilt by the Valuation Division, with accommodations for some fifteen men, a cook and an attendant being furnished for each car. The men sleep and eat in these cars, the railroad moving the cars from point to point as requested by the field engineer.

In going over the first parts of our line, we found many of the fills built on salt marsh or fresh-water swamps, and while there was no evidence of settlement or any signs of mud-waves created by the fills, we felt that there must be a considerable subsidence, if it could be located. To find this we finally adopted the use of wash boring machines. Our fills are, in the most part, made of sand or gravel, and with these wash boring machines we found that we could readily locate the line between the bottom of the sand and gravel and the top of the original peat or marsh. Two machines have been used each year and the work inspected by the Government engineers. During the two years with these machines we have located over 2 000 000 yds. of fill beyond that found by the original cross sections.

In the conferences held between the Engineering Board and the Engineering Committee of the railroads, prior to the starting of actual field work, there were discussions as to how the railroads could check the Government work, and requests from the railroads that they be given copies of the Government notes for use in checking the quantities and in completing their plans. The final outcome of this was a circular issued by the director, to which he attached the form of an agreement which he was willing to have executed between the Division of Valuation and any railroad. By this agreement the Valuation Division agreed to give to any carrier signing it, carbon copies of all field notes taken by the track and roadway party, with the understanding that the railroad would accept these notes as correct, provided no objection was made within thirty days. This agreement was executed by the Boston and Maine Railroad, and we have at all times received carbon copies of all the field inventory notes.

Although this agreement was limited to the track and roadway notes, we have since made arrangements by which carbon copies of all notes and computations made by all the engineering parties are given to us. We are carefully checking the computations, with the result that at the time the inventory is completed we shall be in agreement on the physical quantities as located and enumerated.

The work in connection with inventory of bridges and buildings was started in October, 1914. For these parties both the Government and the railroad furnish one engineer and one computer. Our representative is furnished with copies of all the bridge or building plans which we can find in our files and also information regarding the construction, weights of superstructures and specifications if necessary. The bridge party visit in turn every bridge of over 16 ft. span as they travel along the line, and take sufficient measurements to identify the plans or records which they may have or to compute all quantities in case no plans or quantities are in existence. The building party performs the same work in connection with buildings. For the buildings sufficient measurements are taken so that the cubical contents of each building can be figured, and sufficient notations are made as to the kind of construction of the building as will be necessary in making an appraisal of the building. In the buildings, records are taken of all furniture and fittings other than stationery. The line between the building and the track and roadway party is usually drawn at the building wall, although the building party do take the platforms and awnings, drains directly connected with the building, and in some instances have taken the features outside the building, such as driveways, shrubbery, etc. For our own records we are also taking photographs of each building. Up to the present time these parties have covered some 800 miles, and hope to finish our line some time during the winter. In order to make more speed, we have furnished a motor car for the use of the bridge and building party as it travels over the line. We have recently, also, put on an additional building party which is taking the buildings at the large junction points or terminals.

The signal and interlocking party started late in October,

1914. In the party there are two representatives from the Valuation Division and a pilot from the railroad. This party is taking all measurements necessary for the working up of the various quantities for all automatic signals, crossing and warning signs and interlocking towers. This party has completed some 700 miles to date, and will undoubtedly finish during the winter.

The Valuation Division is also at work making an inventory of the Western Union Telegraph Company, and at the same time making an inventory of the telegraph and telephone property of the Boston and Maine Railroad. For this work we have no representative and have arranged that the representative of the Western Union Telegraph Company look after the railroad's interests. On this work we are receiving carbon notes of the parts owned by us. The work is practically completed.

In all the work of the track and roadway, bridge and building, signal and interlocking and telegraph and telephone parties, no attempt has been made toward fixing the depreciation, although this has been done in some of the other districts. The Government engineers are, however, making careful notations regarding the condition of the various parts as they find them, and on the bridges and buildings have made some attempt towards fixing the service life which can be expected from the various parts of the structures. It is anticipated that the depreciation, or the condition percentage, will only be obtained after a careful study of all maintenance records and operating conditions, and by traveling over the lines with a special train with the proper representatives of the railroad and the Valuation Division.

Order No. 8 was received early this spring. Since that time the Valuation Accountant has had a considerable force employed working up the register for the various items called for in this Order. This registry is most exhaustive. For locomotives, passenger cars, shop machinery, etc., the register has to show a complete history of every individual unit. For freight train cars these can be grouped by series. From a study of one of the register blanks it can be readily seen what an amount of work this entails.

The actual field inspection of equipment by the mechanical

engineer has recently been started, and work is now under way on the inventory of locomotives, cars and shop machinery. For each of these classes the Valuation Division has an inspector, and with him we have placed a pilot, one of our master mechanics for locomotives, our general car inspector for cars, and one of our superintendents of shops for the shop machinery. It is the intention of the Valuation Division to make an actual inspection of every locomotive, every passenger car, 10 per cent. of each series of freight cars and all shop machinery. For the engines and cars a printed form is used, part of which will be filled out from the register, and part from the inspection in the field. In addition to this, after a careful inspection of each unit, the two representatives are agreeing on the maintenance of the unit; as to whether it is normal, above normal or below normal, the normal referring to the maintenance as regards our standard of maintenance, and also as regards the age of the unit.

We are also at work obtaining from our records information regarding every car or engine retired for the last fifteen years. From this it is expected that we can obtain sufficient data as to the average service life of these units. We are also endeavoring to get records from which we can obtain the average mileage which should be expected of a locomotive between shoppings. From all this information the remaining service life or condition percentage of each unit will be obtained. The field inspection for mechanical equipment will be completed this year.

No work has as yet been started by the electrical engineer, but we expect that it will be begun during the next few weeks. The same procedure will pertain to this as to the mechanical equipment.

Lands.

As noted above, the land work for this district is under the direct charge of the valuation attorney. For the actual field work he is being aided by assistant attorneys and by senior and junior appraisers.

As fast as we finish the land maps for a valuation section, prints are turned over to the valuation attorney. In June, 1914, actual field work was started on the land valuation. The first

work in the field is the establishment of zones of land of similar character; that is, our right of way is divided into zones, each zone depending on the character of the adjacent and adjoining lands. In some places the zones are continuous, where the character of the land is similar on both sides of the right of way, but where there is a distinct difference on either side, the zones are sometimes carried along the center of our right of way. These zones are established by actual inspection of the line.

The appraiser next visits the assessors' offices in the district where the railroad is located, and obtains from their records the assessed values of all the adjoining or adjacent lands, noting the comparison between the assessed and the actual values. He then obtains records of all bona fide sales in the locality which can be substantiated, and finally visits representative men, usually real estate men, in the various localities, and obtains from them their opinions of the actual value of these adjoining and adjacent lands. From all this data the appraiser makes his estimate of the normal market value of the adjacent and adjoining lands, which is the so-called basic value to be used in the valuation of our right of way lands. What the next procedure will be has not yet been determined by the Valuation Division.

The railroad land committees have had this question under consideration for a long while. They have asked from all the roads any information which can be given on recent acquisitions, divided so that it would show what the railroads have to pay above the normal market value for consequential or sequence damages, and also the acquisition costs. This information will be compiled and filed with the Valuation Division so as to give to them a record of what might be expected in the acquisition of new railroad lines, and information which the railroads think should be used in the fixing of the values of the rights of way as now owned.

It is ordinarily estimated that the land values of a railroad represent about 30 per cent. of its value. This would mean approximately a five-billion dollar ($5 000 000 000) investment for lands by the railroads of the United States, and from this one can readily judge the importance of this subject. Just how the final values will be fixed is, of course, unknown, but it

is one of the parts of the valuation which will probably lead to the greatest discussions.

The Boston and Maine Railroad, through its land commissioner, has its own representatives at work compiling basic values for use in checking the Government figures. Up to the present time there has been no real coöperation between the Division of Valuation and the railroads on land values. Various schemes have been proposed by the railroads for such coöperation, and the Director himself has expressed himself very strongly in favor of some method of coöperation, but has stated that it is his opinion that the opinions obtained from local parties should be found separately. It is still hoped that some coöperative method will be found so that a large part of the future discussions or differences may be eliminated.

As noted in the discussion of the Act, there are two kinds of land: land owned or used for the purposes of a common carrier, and land held for purposes other than those of a common carrier. Such distinctions have to be shown on the land plans called for in Order No. 1 and on the form filled out in Order No. 7.

The question of lands held for purposes other than those of a common carrier is quite a delicate one, and has lead to many discussions. Various instructions have been issued by the Commission toward the fixing of a definition of carrier land, and instructions have been issued by the railroad land committee to all the railroads giving their opinion regarding it. There are yet some classes of land concerning which there is considerable discussion. At the present time the Government appraisers are working under instructions which state that the real criterion of whether the land is held for carrier purposes is whether there is any immediate prospect of such land being put to actual railroad use.

Accounts.

As noted above, the accounting work for this district is under the direct charge of a district accountant. The work here is being handled by an accountant, who has under him quite a number of assistants. The first accounting work in connection with valuation of the Boston and Maine Railroad was started

by the Government in May, 1914. An attempt was first made to work out the original cost to date of the original Boston and Maine corporation. This corporation was chartered and construction work started in 1835. The accountants were given all books or records which we had in our possession and started to make up the original cost to date, using the present classification and accounting system. After considerable time had been spent on this work the accountants came to the conclusion that from the records available they would not be able to in any way make up such an original cost. This work was then dropped.

Since that time they have been at work on the financial history of the Boston and Maine Railroad. They have attempted to work up full detail of all stock and bond issues, and also to show where all the moneys coming from such issues have been used. They have also made a careful investigation of all operating accounts, endeavoring here to work up a complete statement of all the operating earnings and where all these earnings have been used, as, for instance, operating expenses, additions and betterments, retirements, dividends, etc. It is estimated that up to the present time they have completed perhaps one half of the work which they are to do.

There has been considerable discussion as to whether original cost to date could be ascertained or not. Director Prouty in a speech made before the National Association of Railway Commissioners, in Washington, on November 17, 1914, stated that the valuation accountants had endeavored to work up original cost to date on several railroads so as to ascertain just what might be expected. He stated that one of the instances where this had been done was on the Texas Midland Railroad, which is a road 120 miles long, where the books began about twenty-one years ago. It cost the Government $133 a mile to do the accounting work on the Texas Midland necessary to work out the original cost to date, and it was the opinion of the director that all the work involved in obtaining the original cost to date of this railroad is absolutely thrown away. There are cases where original cost can be found on certain items, and at a joint conference held last May the director put the question before the railroads and the states, as to whether an estimate

should be made where records were not available. To this the railroad reply was, that in case of isolated structures such estimating might be well done, but that as a whole they did not think that it should be so made. The reply of the State Commission to this answer was that the original cost to date should be obtained, no matter how.

This briefly represents the present condition of the valuation work on the Boston and Maine Railroad, and is fairly typical of the work which has been started on various other roads in the United States. On some of these roads the inventory of the physical property has been completed, and in one or two instances preliminary reports have been made on these roads showing the cost of reproduction new and the cost of reproduction less depreciation. In these reports, however, no values were placed on the lands or on any of the contingent items, but just the mere inventory of physical property.

The Division of Valuation is now at practically its maximum development, and it is expected that all the field work and investigations will be completed for the entire country in five years. Just what the valuations will be, or how they will be determined, cannot, of course, be stated. Congress instructed the Commission to investigate many things, and then from this to state the value. It is probable that the many different investigations were called for because of the fact that there are so many theories as to valuation, and it is evident that Congress desired the Commission to investigate all these various theories before fixing their final values.

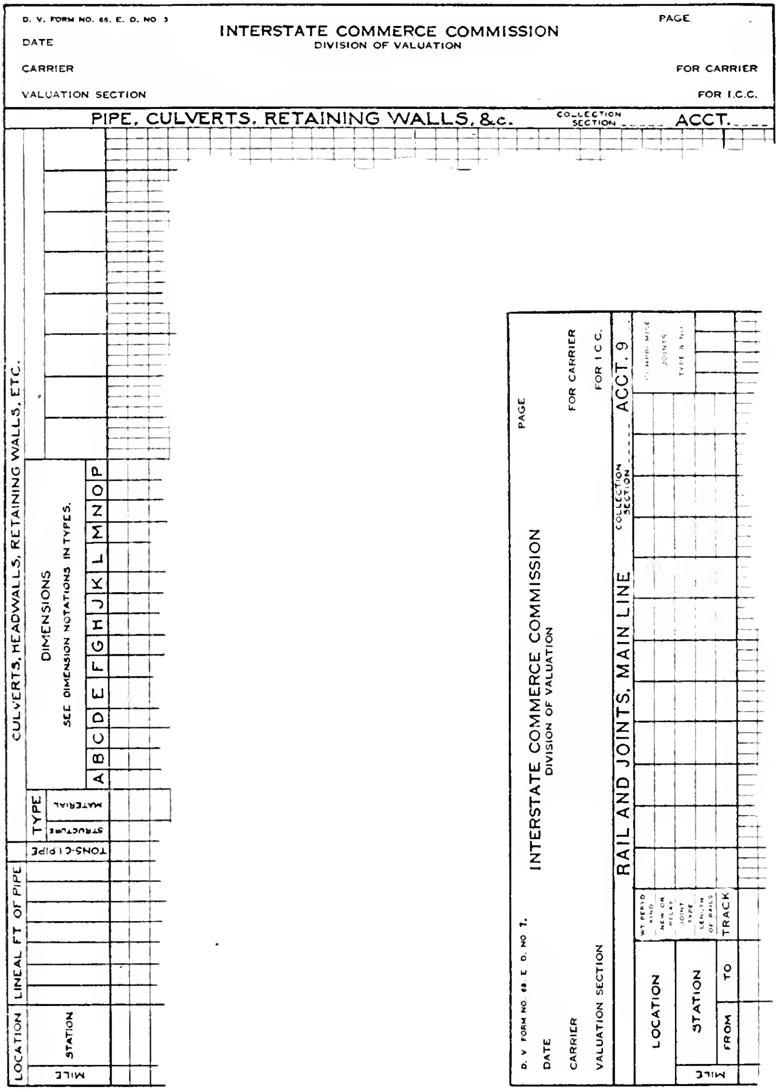
At the present time, important conferences are being held. A conference was held in May between the railroad representatives and the Division of Valuation at which many of the most important items were discussed and a brief filed by the railroads which was answered by the State Commissions. A further conference was held before the Interstate Commerce Commission itself on September 30, at which time the railroads filed a brief giving their ideas and contentions on the main features of valuation, and giving much data supporting these ideas. The principal parts of the brief cover the questions of depreciation, land values, other elements of value, contingencies, unit

prices, joint facilities, and theories on which reproduction new should be based. It is not my intention to enter into any discussion on these general subjects.

The cost of this work, both to the Government and to the railroads themselves, has been widely discussed. The work on the Boston and Maine Railroad will consume over two years, possibly three, during which time a maximum organization of 130 will have been actively at work. We estimate that the cost to the railroad will be at least $100 per mile and probably more, and that the cost to the Government will be at least an equal sum. The cost on other roads will vary, depending upon the conditions, some more and some less, but it is anticipated that at least $100 per mile will be expended by all the railroads in the country, and that the Government will probably spend a similar amount. This will make the total cost of valuation approximately $50 000 000.

Many questions have been asked as to the accuracy of the inventory of the physical property. We have always found that the Government engineers are anxious to arrive at as correct results as can be obtained, and it is probable that the errors in the parts that can be readily seen will be small. In the grading and masonry, however, there are many chances for loss. No one knows how thick or how deep many of the masonry walls or abutments are, or what may be under them. For the grading, the original surface of the ground is always a matter of guess. A comparative test was made last year by the Delaware and Hudson Company, on the cross-sectioning of a part of their line. One party made cross sections, using first the Lock level, second the "Y" level, and third using a transit and level. It was found that the same party doing the cross-section work by these various methods obtained practically uniform results, but that when a second party did the work, using the same methods, their results were uniformly alike, but differed from the results obtained by the first party. In other words, the mere personal element shows much variation in results obtained. It is then evident that with all the care that can be taken, there is liable to be a considerable loss to the railroads on some items such as grading and masonry.

[Reproductions of a few of the many forms required in the railroad valuation work are shown on the following pages. — EDITOR.]



D. V. FORM NO. 66. E. D. NO 3

INTERSTATE COMMERCE COMMISSION
DIVISION OF VALUATION

DATE
CARRIER
VALUATION SECTION
PAGE
FOR CARRIER
FOR I.C.C.

PIPE, CULVERTS, RETAINING WALLS, &c. COLLECTION SECTION ____ ACCT.____

CULVERTS, HEADWALLS, RETAINING WALLS, ETC.

DIMENSIONS
SEE DIMENSION NOTATIONS IN TYPES.

A B C D E F G H J K L M N O P

TYPE: MATERIAL, STRUCTURE

TONS-C I PIPE

LINEAL FT OF PIPE

LOCATION: STATION, MILE

D. V. FORM NO. 68 E. D. NO 7.

INTERSTATE COMMERCE COMMISSION
DIVISION OF VALUATION

DATE
CARRIER
VALUATION SECTION
PAGE
FOR CARRIER
FOR I.C.C.

RAIL AND JOINTS, MAIN LINE COLLECTION SECTION ____ ACCT. 9

WT PER YD, KIND, NEW OR RELAY, JOINT TYPE, LENGTH OF RAILS, TRACK

JOINTS

LOCATION
STATION
MILE: FROM, TO

D. V. FORM NO. 311.
PAGE
DATE
CAR NO.
FIELD SHEET NO.
INITIALS

INTERSTATE COMMERCE COMMISSION

DIVISION OF VALUATION

54—PASSENGER TRAIN CARS

CARRIER ... FOR CARRIER
STATION ... STATE ... FOR I. C. C.

Builder ; date built ; owner's plate
Bought of ; date bought ; kind of car
History

IDENTIFICATION.

1. Capacity, passengers ; pounds ; weight	28.
2. Length over end sills width over side sills	29.
3. Body, kind	30.
4. Roof, kind	31.
5. Underframe, kind	32.
6. Body bolsters, kind	33.
7. Body cross-ties, kind	34.
8. Air brake equipment schedule	35.
9. Trucks, kind	36.
10. Truck bolsters, kind	37.
11. Wheels, No. ; kind ; diam.	38.
12. Journals, size	39.
13. Axle generator, kind ; volts	40.
14. Batteries, kind ; No. of cells	41.
15. Draft rigging, kind ; maker	42.
16. Platform, kind	43.

17. Vestibule, kind ....
18. Partitions, No.......; kind..........
19. Toilet rooms, No..........
20. Toilet hoppers, No.......; kind..........
21. Interior finish..........
22. Seats, No.......; kind..........
23. Upholstering, kind..........
24. Light, electric.......; gas.......; oil..........
25. Heat, kind.......; maker..........
26. ....
27. ....

44. ....
45. ....
46. ....
47. ....
48. ....
49. ....
50. ....
51. ....
52. ....
53. ....
54. ....

GENERAL CONDITION AND DEFECTS.

Exterior of body..........
Interior of body..........
Underframe..........
Draft gear..........
Platforms..........
Trucks..........

Maintenance, normal, above or below..........

Service condition per cent.	Per cent.	Weight.	Net per cent.
Body..........			
Trucks..........			

12—828

Form approved March 6, 1915.

D. V. FORM NO. 308.

INTERSTATE COMMERCE COMMISSION

DIVISION OF VALUATION

51—STEAM LOCOMOTIVES

DATE		PAGE
FIELD SHEET NO.		LOCOMOTIVE NO.
CARRIER		INITIALS
STATION	STATE	FOR CARRIER
		FOR I. C. C.

Builder ; builder's No. ; date built ; owner's plate

Bought of ; date bought ; service

History

IDENTIFICATION.

1. Type, Whyte symbols
2. Size of cylinders
3. Diameter of drivers over new tires
4. Tender capacity, water ; fuel
5. Engine truck wheels, kind ; diameter
6. Driver brakes, kind
7. Driving wheel centers, kind ; diameter
8. Superheater, kind
9. Main steam valves, kind
10. Valve gear, kind
11. Air reservoir, No. ; size
12. Air pumps, No. ; make
13. Air pumps, S or C ; size
14. Air brake equipment schedule
15. Headlights, No. ; kind
16. Train signal, kind
17. Working steam pressure
18. Boilers, type
19. Boilers, diameter at first ring
20. Fire box, type
21. Fire box, dimensions
22. Combustion chamber
23. Flues, No. ; O. D. ; length
24. Tender, type
25. Tender frame, kind
26. Tender wheels, No. ; kind ; diam.
27. Tender trucks
28.
29.
30.
31.
32.
33.
34.

GENERAL CONDITION AND DEFECTS.

Boiler

Fire box

Flues

Cylinders

Frames

Wheel centers

Tire thickness, " wear "

Valve motion

General machinery

Tender trucks

Tender underframe

Tender cistern

Last general repairs, date of

Mileage since last general repairs

Total mileage expected from same

Maintenance, normal, above or below

Service condition per cent.	Per cent.	Weight.	Net per cent.
TENDER			
Trucks			
Underframe			
Tank			
ENGINE			

Form approved March 6, 1915.

12—825

D. V. [illegible] 78
Owner
Operating Company
Date of Report as of
Correct
Title

INTERSTATE COMMERCE COMMISSION
DIVISION OF VALUATION

51—STEAM LOCOMOTIVES
REGISTER OF EQUIPMENT

Sheet No. of sheets (this form)
All locomotives on this sheet for track of gauge
Supporting data will be found on D. V. Form No. , sheets

Locomotive No.	Initials. (Owner.)	Builder.	Builder's No.	Date Built Mo.	Date Built Yr.	Type (Whyte Symbols.)	Cylinders. (Diameter and Stroke.)	Service.	Diam. Drivers Over New Tires.	Working Steam Pressure.	Weight on Drivers.	Tractive Effort by I. C. C. Formula.	Diam of Boiler Outside First Ring.	Tender Capacity. Water. (Gallons.)	Tender Capacity. Fuel.	Weight Light. Engine.	Weight Light. Engine and Tender.	Mileage to Date Since Last General Repairs.	Remarks.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)

D. V. FORM NO. 88. E. D. NO. 2.

INTERSTATE COMMERCE COMMISSION
DIVISION OF VALUATION

PAGE

DATE.
CARRIER
VALUATION SECTION

FOR CARRIER
FOR I.C.C.

CHAINING NOTES

COLLECTION SECTION .... CHAINING

Location: Mile	Location: Station From	Location: Station To	Location: See Carrier's Plan No.	Length of Mile in Feet	Equalities: Station by Back Chaining	Equalities: Station by Forward Chaining	Remarks and Sketches.

MEMOIRS OF DECEASED MEMBERS.

ALEXIS H. FRENCH.*

OUR fellow-member and past-president, Alexis H. French, died at his Brookline home early Monday morning, May 3, 1915. He had quietly celebrated his sixty-fourth birthday a few hours before, and his sudden death was a great shock to all about him.

Mr. French's death, while sudden, was not altogether unexpected. He was a victim of arteriosclerosis which brought him premature old age in a few months and ended in a painless sleep which had no waking.

Last autumn, he was obliged to give up his full participation in public affairs and attend to only such matters as were brought to him from time to time. During the fall and winter he hoped and planned to resume his usual duties, but early this year, at his request, he was given leave of absence from the first of March without pay.

Mr. French had been town engineer since the establishment of the Engineering Department by the town in 1894. Prior to that time he had done the larger part of the public engineering work since he came to Brookline in 1871, thus making an enviable and nearly unbroken record of service of forty-four years.

Mr. French was born May 2, 1851, at North Weymouth, Mass. His parents were Henry J. and Lucy H. (White) French, and he leaves, in addition to his wife, a brother, D. Willis French, a water-works engineer of New York, and widowed sister, Mrs. John Libbey, of Weymouth.

The education afforded by the Weymouth High School was supplemented by the purchase of an apprenticeship in the office of Shedd & Sawyer, of Boston, at that time one of the

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* Memoir prepared by Edward W. Howe and Henry F. Bryant.

best-known engineering firms of the country. Not fully satisfied with the amount of definite instruction received in this way, he took a position in 1871 as assistant to Mr. George Tyler, then acting for the Town of Brookline as engineer and superintendent of streets. He later entered the Massachusetts Institute of Technology as a special student, associated with the class of 1873, successfully spending there two detached years, which was all the time he felt he could afford.

On the retirement of Mr. Tyler in 1875, Mr. French was given an office in the Brookline Town Hall, which he shared for some time with the superintendent of streets. In consideration of the use of this office, special reduced rates were fixed for services furnished the town, and both public and private business was conducted there. This arrangement continued until 1894, when the salaried office of town engineer was created and Mr. French was appointed.

On January 14, 1880, he married Miss Alice Blanchard Loud, of Weymouth, and not long after built their home on the corner of Cypress Street and Cypress Place. There are no children.

Mr. French was identified with the greater part of the material development of Brookline. He saw the town grow from a population of 8 000 to one of 30 000. Except for the initial work on the main outlet sewers, the entire sewerage and drainage system of the town was constructed under his direction. This is underground and largely forgotten. It nevertheless represents a large expenditure and involved many difficulties which have been successfully overcome.

The park and playground system, with but few minor exceptions, was installed and maintained under the direction of Mr. French. This is a visible and constantly appreciated monument to the skill with which his own and the designs of others have been carried out at reasonable expense and in permanent form.

The stone arches across Muddy River and its branches, from Carlton to Chestnut streets, were nearly all designed in his office and were all built under his direction. They are examples of the best of taste. The Longwood Avenue arch, when

built, was one of the longest spans in this country and is a favorite subject for artists and photographers. The construction of this bridge was modestly described by Mr. French in a paper presented to this Society.

The laying out of new bridges, new streets, and the widening of main thoroughfares has also been a large part of the work of Mr. French in both his private and public capacity. The grade-crossing eliminations at Washington and Cypress streets, the several widenings of Boylston and Hammond streets, were among the important items.

Alongside of the matters mentioned, there has been the great mass of minor public matters which really make up the major part of the professional work of a municipal engineer. This incidental work was steadily increasing for many years, due to the modern tendency to make of the municipal engineer the technical executive of all public affairs. Mr. French's ripe experience and wide observation made his judgment valuable and in constant demand.

The title of town engineer indicates but slightly the importance and extent of Mr. French's work. Brookline as a town is unique in having what is probably the largest population of any municipality retaining the old New England form of town government, and, moreover, in having the valuation and consequent activities of a city several times its size. Such a condition required engineering service of high order.

Mr. French was a member of numerous social, technical and quasi-public bodies, viz., the American Society of Civil Engineers, the Boston Society of Civil Enginerers, the Engineers' Club, the Appalachian Mountain Club, the Massachusetts Highway Association, the National Geographic Society, Harvard Church and Brotherhood, the Boston Congregational Club, the Brookline Historical Society and the Technology Alumni Association. He was active in the affairs of many of these bodies, as is evidenced by his holding the office of president in our own Society in 1900–1901, having served as vice-president for the two preceding years. He was also a past-president of the Appalachian Mountain Club and was one of its trustees of real estate at the time of his death.

In 1874, he joined the Harvard Congregational Church, and has since been an active worker in its interest, being president of the Brotherhood at one time and for a long time member of the Prudential Committee.

Mr. French joined this Society in 1874, at the time of its rejuvenation, and was one of about a dozen who now represent our oldest membership. His interest in the affairs of the Society has been constant and took a final concrete form in the provision of his will, leaving $1 000 to the Society, the income to be devoted to the library.

In 1894, when appointed town engineer, he formed a partnership with one of his assistants, under the name of French & Bryant, by which firm all private professional business was conducted until he withdrew his name in 1908. From the time of his appointment as town engineer, Mr. French devoted all his time to public affairs and none whatever to private business. Nevertheless, to remove all possible misunderstanding, he thought it wise to sever his connection with the latter.

About the year 1890, Mr. French took up photography as a recreation, and practiced the art with his usual care and success until recently. The number of his pictures was smaller than for most amateurs, but his successes were more numerous and his failures few. His collection of mountain views made for the Appalachian Mountain Club, and other views presented to his friends, is worthy of great praise for its execution and its taste.

By thrift and good management of his affairs, rather than by unusual income, Mr. French accumulated a considerable property, particularly in real estate. Such a result should be gratifying and inspiring to all engineers, especially if it be accompanied, as in this case, with the honor and love of his fellowmen.

No citizen of Brookline ranked higher than Mr. French for kindliness and for integrity and devotion to public and private duty. His methods were quiet and unostentatious, were absolutely above political or personal influence, and they contributed much toward the enviable reputation of the town for simple, unbiased and efficient administration of public affairs.

BENJAMIN GREELEY FOGG.*

Benjamin Greeley Fogg was born in Gorham, Me., March 11, 1881. He received his preparatory education in the public schools, graduating from the Newburyport High School in 1902. In 1902 he first entered the Massachusetts Institute of Technology. In 1904 he entered the United States service as civil engineer with the Philippine Civil Government. He served abroad from March, 1904, to July, 1906, being chiefly engaged on topographical survey work and highway construction.

In 1906 he returned to the United States and re-entered Technology, but was obliged to relinquish his studies there on account of poor health. The next year he accepted a position as instructor of civil engineering in the Pennsylvania State College for a while, but returned to the Institute and completed his course, receiving the degree of S.B. in 1908 and resuming teaching in the Pennsylvania college the same year.

In 1909 he became connected with the Aberthaw Construction Co. of Boston, being at first employed on construction work in Maine and shortly afterwards entering the Boston office of the company, where he assisted in developing their system of cost accounting.

In 1913, on physician's advice, he sought outdoor employment and was transferred to the field work of the company, in which he continued in New Hampshire and Maine until shortly before his death, which occurred on March 14, 1915, at Newburyport, Mass.

He was married in 1908 to Miss Katherine E. Knight, who, with a daughter, survives him.

Mr. Fogg was esteemed and liked by all who came to know him. He was of a kindly disposition, not easily ruffled, and ready with help to all his associates. To his associates, both in his painstaking work in the developing of the somewhat intricate system of cost accounting in the Boston office, and in its practical application in the field, his loss is greatly felt. They all know that by his untimely decease they have lost a valued fellow-worker and a real friend.

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* Memoir prepared by Leslie H. Allen and J. A. Garrod.

ISAAC RICH.*

ISAAC RICH was born in Brookline, Mass., on October 6, 1856, and died March 11, 1915. He suffered from angina pectoris for a long time, but the final end came to him suddenly at his home, 36 Walnut Street, Somerville, Mass.

He was the son of the late Thomas and Maria L. Rich, of Brookline; and a descendant of Richard Rich, of England, who came to the Colonies, and first settled for a while at Dover, N. H., and in 1680 moved to Eastham, Mass., on Cape Cod. His parents moved to Boston when he was three years of age, and all the associations of his boyhood and early manhood were with the South End. He was graduated from the Boston English High School in 1875, and was in the class of 1878 at the Massachusetts Institute of Technology.

During the working years of his life he has been employed as a civil engineer, and for the greater part of the time on railroad construction. During the Institute vacation term of 1877, he was employed from June to October as a rodman on the surveys of the Boston, Hoosac Tunnel & Western Railroad between Hoosick Falls and Mechanicville, N. Y. From August, 1878, to June, 1879, he was employed as rodman and leveler on the line of the Atchison, Topeka & Santa Fé Railroad through the Royal Gorge and Grand Canyon of the Arkansas in Colorado, working under Mr. Joseph O. Osgood, C.E., a former resident of Boston.

Returning to Boston, on June 11, 1879, he secured a position as leveler with the New York & New England Railroad, under Mr. L. B. Bidwell, chief engineer, and was stationed at Danbury, Conn. There he was associated with Mr. D. G. Penfield, division engineer, on the construction of the part of the main line from Danbury, Conn., to Towners, N. Y., and remained on that work until December, 1880, when the construction was practically finished. In a few days he started West again, having accepted a position as division engineer on construction of the California Southern Railroad, under his former employer, Mr. Osgood, who has then chief engineer.

* Memoir prepared by George T. Sampson, F. B. Rowell, and T. P. Perkins.

He was soon after promoted to the position of resident engineer and had supervision over four divisions covering about 58 miles of the 126 miles between San Diego and Colton, Cal. He continued in this position until June, 1882, when he again returned to his home and friends in Boston.

He was then again employed on the New York & New England Railroad as an assistant engineer until August, 1885, being meanwhile engaged on a great variety of work: preliminary lines, estimates and the construction of coaling stations and similar works, necessary for the maintenance and development of a growing railroad property. In the summer of 1883 he worked on the preliminary surveys from Allyn's Point to Groton, Conn., for an extension of the Norwich & Worcester Railroad, which was afterwards built in 1898. He personally made the plans, profiles and estimate of cost.

His next employment was with the Napa Consolidated Quicksilver Mining Co. at Oak Hill, near Calistoga, Napa County, Cal., where his position was that of assistant superintendent and accountant, which he filled from August, 1885, to September, 1888. He was also engineer on the property and had much to do in the construction of roads, railroads, new water supply and rebuilding of furnaces, as well as in making underground surveys and surveys of the land and mining claims. As additional duty, he kept the accounts and purchased supplies.

He was then employed for a third time with the New York & New England Railroad for the four years following October, 1888. His most important work at this time was as assistant engineer of the Suburban Railroad, a subsidiary corporation which was chartered for the purpose of building a line from Cook Street near Newton Highlands on the Woonsocket Branch to a connection with the main line of the New York & New England Railroad at Dorchester. It was a project which in one form or another had been under consideration for many years, and there was much to be said in favor of it at that time. He made the field surveys, and advanced the work to the making of the final location and plans, sufficient to have started construction had the conditions proved favorable.

His next employment was with the Boston & Maine Rail-

road from September, 1892, to April, 1895, as assistant engineer and division engineer, on the lines between Springfield, Mass., and Sherbrooke, P. Q., and on the St. Johnsbury & Lake Champlain Railroad, with office at St. Johnsbury. While there he reported to Chief Engineer Bissell. He was also employed for a short time at Boston in charge of general engineering work on the southern and eastern portions of the Boston & Maine system.

From April, 1895, until the close of his active years, he was employed with the New York, New Haven & Hartford Railroad on that part of the system which was the original Old Colony Railroad, as assistant engineer in the office of the division engineer at Boston. He at first worked with Mr. George S. Merrill, division engineer, and later with his successor, Mr. J. W. Pearson. During this term the growth and expansion of the railroad system was rapid and continuous, and the work on which he was engaged had all the variety and interest which falls to the lot of a civil engineer in railroad practice both on new construction and on maintenance. He was personally employed on work for the elimination of grade crossings at Harwich; at Buzzards Bay; at Norton Furnace; at Rockland Street, Hingham, and at Main Street, North Falmouth, Mass. He handled dock work at Newport and Fall River; the extension of second track, and the building of new stations at many places on the division.

On May 10, 1912, he was obliged to resign his position on account of ill-health, and passed his remaining years quietly at his home in Somerville.

He became a member of the Boston Society of Civil Engineers, April 16, 1890, and of the American Society of Civil Engineers in 1903.

In 1889 he married Miss Alice Montague Vinal, daughter of the late Robert A. and Almira L. Vinal, and since then made his home in Somerville at the Vinal homestead, corner of Walnut and Aldersey streets. He leaves a widow, a brother, Henry Rich, and a sister, Mrs. John A. E. Hussey, both of the latter being residents of Brookline.

Mr. Rich was unassuming in his manners, of quiet deport-

ment, genial and kind in his disposition, a man of the true type. He was methodical in business affairs, prompt and punctual in all his appointments, regular and upright in conduct, of fair fame and good character. He gave his best service to his employer, and was best contented when fully employed.

His interest centered in his work and his home.

Vol. II NOVEMBER, 1915 No. 9

BOSTON SOCIETY OF CIVIL ENGINEERS
FOUNDED 1848

PAPERS AND DISCUSSIONS

THE ARROWROCK DAM.

By Chas. H. Paul,* M. Am. Soc. C. E.

At the time that the construction of the Boise (Idaho) Project of the United States Reclamation Service was undertaken, irrigation development in the Boise River Valley had proceeded to the extent that all the low water flow of the river had been appropriated. As the low water period occurred during the irrigation season, this meant that storage works became an essential feature of the Boise Project from its inception.

Extensive investigations were made to select the most favorable site for a storage reservoir. The combination of suitable dam and reservoir site was difficult to find, and it finally developed that for the best solution of the problem, and full development, a dam at Arrowrock, higher than any that had ever been built, would be required.

The construction of this dam, which was started in 1911, has been finished, and it was in service during the irrigation season of 1915, while the last stages of the work were being completed.

Note. — This paper is an elaboration of a talk on the same subject given by Mr. Paul before the Society on January 7, 1914, before the dam was completed.

Discussion is invited, to be received by Edward C. Sherman, Editor, 6 Beacon Street, Boston, before January 10, 1916, for publication in a subsequent number of the Journal.

* Construction Engineer, Arrowrock Dam, U. S. Reclamation Service.

Description.

The Arrowrock Dam is located on the Boise River, twenty-two miles above the city of Boise, Ida. The maximum height of the dam is 348.6 ft., its length is 1 100 ft., it contains 585 200 cu. yds. of concrete and it has a gravity section but is built on a curve of 660 ft. radius. The lowest point of its foundation is 90 ft. below the river bed. There are 20 outlets through the dam, each 4 ft. 4 in. in diameter, and each controlled by a 58-in. balanced needle valve set on the upstream face. These outlets are arranged in two sets of ten each, the upper set being about 110 ft. below the top of the dam and the other set about 90 ft. lower. There are also, just at the old river level, five sluicing outlets 5 ft. in diameter, each controlled by a sliding gate. All gates are operated from chambers within the dam. Inspection galleries, of which the control chambers form a part, give access to the interior of the dam at several different elevations.

The spillway has a capacity of 40 000 sec.-ft. The weir is 400 ft. long and extends back upstream from one end of the dam at about a right angle to a tangent to the curve at that point. A discharge trench picks up the water along the toe of the weir and carries it past the end of the dam to the canyon of a creek that enters the river a few hundred feet below the dam. This spillway trench was excavated through solid rock, and is lined with concrete having a minimum thickness of 24 ins. and reinforced with $3\frac{3}{4}$-in. bars, on 12-in. centers both ways. In the trench lining and the weir are 25 400 cu. yds. of concrete, making the total concrete in the dam and spillway 610 600 cu. yds.

The total excavation for dam and spillway amounted to 682 000 cu. yds.

Preliminary Work.

Preliminary to the construction of the dam, a standard gage railroad 17 miles long was built from Barberton, the end of a railroad spur out of Boise, to the dam site. Regular train service over this line has been maintained since its completion in November, 1911, and during the four years it has hauled about 80 000 passengers and nearly 15 000 000 ton miles of freight.

There was a fairly good power site at the diversion dam at the head of the main canal, about 14 miles below Arrowrock, and as coal is expensive, and of poor quality for storing, it was decided to build a hydro-electric power plant, and to use electrically driven equipment for the construction plant so far as practicable. This power plant has a maximum capacity of 3 000 h.p. Duplicate transmission lines were built from the plant to Arrowrock, and no interruptions of service worth

FIG. 1. ARROWROCK DAM — EXCAVATION.
(Looking downstream.)

Showing diversion tunnel, upper cofferdam (partly completed), main cableways, drag line excavator and steam shovel outfit.

mentioning have occurred since the power plant was put in operation in May, 1912.

The Arrowrock Dam is located at a sharp bend in the river channel, and a tunnel 500 ft. long carried the river past the work during the construction period. (Fig. 1.) The capacity of this tunnel was at least 30 000 sec.-ft. Earth filled, timber-

crib cofferdams turned the river into the tunnel and protected the work below river level from back water. This tunnel was filled with concrete for a length of about 200 ft., which came within the dam section, after it had served its purpose.

A modern construction camp, with water supply, sewerage system, general store, hospital, bathhouse, laundry, clubhouse and other features to make it complete, sanitary and attractive, was erected at a convenient location just below the dam site. As there was no town nearer than Boise, this camp had to provide for the comfort and amusement of the men and also the families of many of them who had put up shacks of their own in the immediate vicinity of camp.

Sanitary Precautions.

At once, the problem of sanitary protection became of vital importance. It was comparatively simple to care for the main camp, which was under the absolute control of the Reclamation Service, but when little settlements began to spring up here and there, as more and more of the men brought their families to the job, the problem became more complex. Fortunately, public sentiment was all in favor of enforcing the necessary regulations. These covered the location, proper construction and disinfection of toilets, disposal of garbage, protection of water supply and the fighting of flies. The camp physician was given the duties of chief sanitary officer, and under his direction the camp foreman and his crew of janitors and camp men looked after the main camp. To aid in the proper enforcement of the necessary regulations outside of the main camp, it was arranged to look after the necessary work like disinfection, garbage collection, the furnishing of garbage cans, fly traps, etc., at a certain fixed charge for the service performed, and nearly all of the persons living outside of the main camp were glad to take advantage of this arrangement.

All applicants for employment were given a brief physical examination by the resident physician, which was made more thorough if deemed advisable. In this way the unfit or undesirable were eliminated. Vaccination for smallpox or antityphoid inoculation was given at the hospital without charge.

Air-tight metal garbage cans were provided, and were kept in serviceable condition. Garbage and refuse were collected every day or two, hauled away and burned. No breeding places for flies were allowed to exist. Fly traps were used constantly. All toilets and buildings where flies would be attracted were screened and provided with special screened entrances. Sleeping quarters were scrubbed, aired and disinfected frequently. Iron springs and mattresses were provided, and these were taken out and cleaned periodically. The cost of this work was not high, but the results were most satisfactory, as the general health of the community has always been away above average: there have been no epidemics of any kind and only one case of typhoid, which probably originated outside of camp.

Construction.

The construction of the dam was authorized in January, 1911. Immediately the preliminary work was started and work on final designs was begun. In the spring of 1912 the railroad, power plant, camp and diversion works had been practically finished. Excavation in the river bed was started in February, 1912.

Excavation for Dam Foundation.

The depth to bedrock for the foundation of the dam was from 70 to 90 ft. below the river bed. The width of the canyon at the river bed is about 200 ft., and the thickness of the dam at the bottom is 240 ft. The estimated amount of excavation in the river bed was 230 000 cu. yds. On account of the amount and depth of this excavation, the uncertainty as to the amount of pumping that would be required and the possibility of a flood that might cause trouble during the high water period in the river, it was decided not to open up all of the excavation at once, but to excavate for, and build first, a section of the dam along the upstream face, extending entirely across the canyon, with a maximum height of about 100 ft., which would bring its top well above high water, and with a cross-section heavy enough to stand by gravity. After this first section was built, the re-

mainder of the river bed excavation was taken out and the whole dam completed to the elevation of the top of the first section.

The material in the river bed was largely gravel and sand with 5 per cent. to 10 per cent. of bowlders, all of which was good material for concrete; but along one side the material was principally large granite bowlders mixed in with dirty material not fit for use. This was moved by a steam shovel, loaded into dump cars and wasted along the river bank, above and below

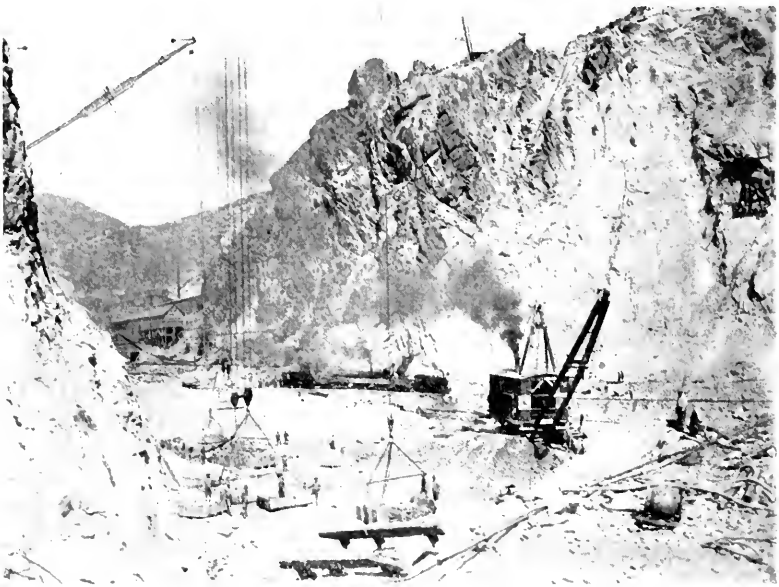

FIG. 2. ARROWROCK DAM — EXCAVATION.
(Looking downstream.)

Showing drag line excavator and steam shovel outfit. Loaded skips being picked up by cableways.

the dam site (Figs. 1 and 2). The rest of the material was taken out by cableways, screened and stored for use in concrete. Two cableways were erected so as to cover this work to good advantage. A drag line excavator, working in the pit between the lines of these two cableways, loaded the material into skips which were then lifted and conveyed by the cableways to a large

hopper at one side of the river, under which was located the screening and crushing plant. Two stiff-leg derricks, located at one side of the river on the edge of a steep cliff, commanded a portion of the excavation that could not be reached conveniently by the drag line. Orange-peel buckets, operated from these derricks, were used in excavating the pump sumps and cleaning up the corners. Cableways and derricks were operated by electric motors. Pumps and motors were mounted on a truck, and were let down the slope of the excavation by hand crabs.

After the first section of dam was built, the upstream cableway was moved to another position further downstream, and the remainder of the river bed excavation was handled in the same way as that for the first section.

On the south side of the river at the dam site, there is a lava bench, overlying the granite, the line of contact at the face of the cliff being about 20 to 25 ft. above river level. This lava rock varies in thickness from about 50 ft. at the edge of the cliff to about 20 ft. against the hillside. The width of the bench is about 200 ft. This lava rock was not suitable for foundation, and about 50 000 cu. yds. of it had to be removed. It was handled by skip, drag line and cableway, the drag line being used on a revolving derrick for spotting and skips. As much of the rock as was suitable was used as plums in the concrete. The remainder was taken away by cableway and dumped into the river below the dam, serving as backfilling against the downstream face below river level.

The work of cleaning up abutments, cutting key ways, etc., was done with a small crew, just ahead of the concreting, without the use of explosives except in very light shots.

Concrete.

Material for concrete was obtained from the river bed excavation, until that was used up, and later from a pit about 13 miles below Arrowrock, just off the line of the railroad. The material was screened to three sizes, sand, gravel (to $2\frac{1}{2}$ in.), and cobbles ($2\frac{1}{2}$ to $5\frac{1}{2}$ in.). The oversize passed to crushers and then back to the screens. A set of bins over each mixer held

about four hours' supply of material. Sand cement composed of 55 per cent. Portland cement and 45 per cent. pulverized granite, reground to pass 90 per cent. through the 200-mesh sieve, was manufactured on the ground. Ample bin storage was provided at the sand cement plant, and all sand cement, before being used, was tested for soundness and tensile strength, using the approved standards for Portland cement. Of the 586 500 barrels manufactured in connection with this work,

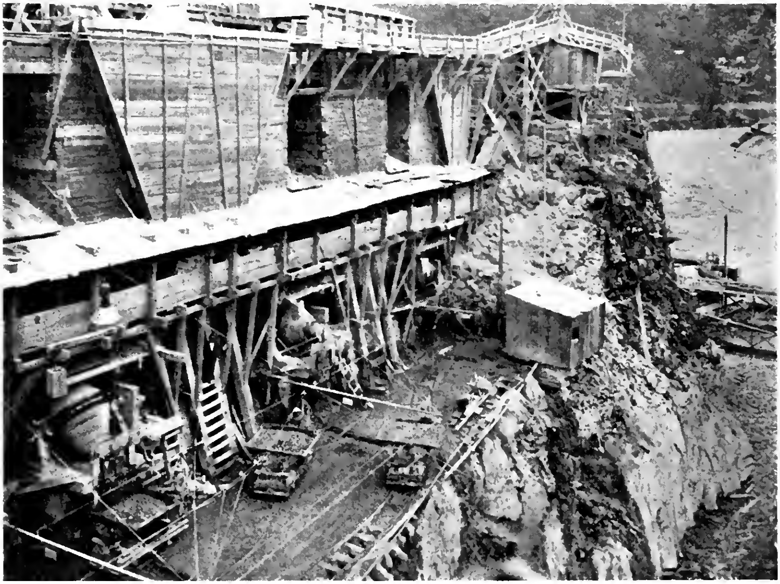

FIG. 3. ARROWROCK DAM — CONCRETE PLANT.

Showing storage bins, mixers and rocker dump, electric trolley cars, transporting concrete to distributing tower.

there has not been a failure of any of the sand cement to pass these standard tests. The sand cement was transported from its storage bins to bins over the mixers through 3-in. pipe lines by means of compressed air.

The concrete was mixed, 1 part sand cement, $2\frac{1}{2}$ parts sand, 5 parts gravel and $2\frac{3}{4}$ parts cobbles, with such temporary modifications as conditions demanded. In the toe of the dam and

for a thickness of about 10 ft. against each face, a richer mix, about 1 : $2\frac{1}{2}$: $4\frac{1}{2}$: $2\frac{1}{2}$, was used. This "face mix" was obtained usually by adding a sack of Portland cement to the regular mix.

The sand, gravel and cobbles from their respective bins were fed by gravity to the mixers, through adjustable measuring boxes controlled by gates operated by compressed air. These materials were measured by volume; but the sand cement was weighed out, on account of the inaccuracy of volume measurement for material of such extreme fineness. The cement bin gate was operated by hand, and through it the sand cement was fed into a tight metal box with hinged bottom, hung on steelyards. On signal from the mixer man, all materials were dumped into the mixer almost simultaneously. Water was added at the mixer. There were three 1-cu. yd. mixers in the plant, driven by electric motors, each mixer with its measuring boxes and bins forming an independent unit (Fig. 3).

Below each mixer was a hopper with a capacity of one batch. The carriers for the mixed concrete, which will be described later, each had a capacity of two batches (2 cu. yds.).

The concrete was distributed by cableways — not the main cableways that were used for the excavation and general work, but smaller ones assembled from equipment already on the job or made up at the shops. Their span was from about 500 to 700 ft. For the work below river level, they were stretched between the steep cliffs on either side, and picked up the concrete direct from the hoppers below the mixer. Later, a high tower was erected near the center of the dam which served as a common tail tower and loading point for the three cableways, two running north and one south from this tower (Fig. 4), and the concrete was carried from the hoppers below the mixers to the foot of this tower by 2 cu. yd., rocker dump, electric trolley cars (Fig. 3).

The cableway bucket, after being loaded, was hoisted and taken out to a hopper, hung from another carriage on the same cableway, into which hopper the bucket discharged its load under the control of the cableway operator. From the bottom of the hopper was hung a chute, 40 ft. long, the free end of which was suspended from auxiliary cables and could be swung at will

to any point within a circle of 40 ft. radius. The position of the hopper, along the cableway, was controlled from the head tower, and it could be moved from point to point with no loss of time between batches.

This method was used until the work was carried to within about 50 ft. of the top of the dam, after which the main cableways took the concrete to distributing hoppers at either end of the dam, and the electric dump cars, running on a trestle just

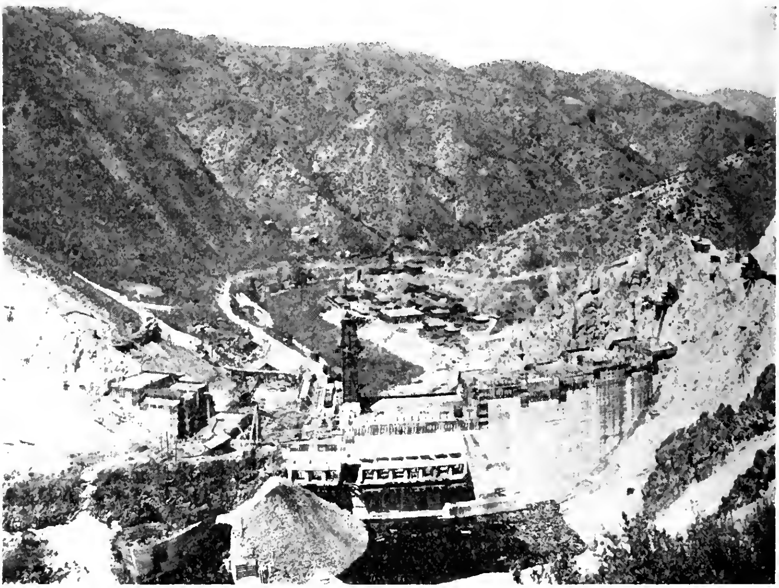

FIG. 4. ARROWROCK DAM — CONCRETE WORK.
(Looking downstream.)

Showing tower for concrete distributing cableways, method of handling work and forming contraction joints, trash rack structures (on upstream face) for outlet gates. Portion of camp in distance. Top of dam will be 50 ft. higher than top of tower.

above the work, distributed the concrete from these hoppers.

In placing the concrete, the most scrupulous care was taken to see that the bedrock, or the old concrete surface, was thoroughly clean and free from loose particles. The process of cleaning left the surfaces thoroughly wet. Then a neat cement

grout, mixed fairly thin was slushed over the surface just ahead of the concrete, and scrubbed in with steel brooms. On bed rock, and whenever necessary on old concrete, a batch or two of mortar preceded the regular run of concrete.

Concrete was mixed of plastic consistency. The proper slope of the chutes was between 20 and 25 degrees from the horizontal. Concrete of plastic consistency would move on this slope freely, but without separation of material, and an excess of water was neither necessary nor desirable.

Grouting Foundation.

The foundation of the dam was granite, of excellent quality. The rock was free from evidence of faulting, crushing or shearing, but was characterized by rather frequent parallel joints, giving the rock a sheeted structure which has a north and south (across canyon) trend, and a high dip upstream. On account of the unusual height of the dam it was decided to grout the foundation and abutments at the heel, although it was thought that the seams would take very little grout.

The grout holes were drilled from the bottom of the keyway along the heel of the dam. Most of them were 25 to 30 ft. deep. Two rows of holes were drilled, 5 ft. and 13 ft. deep, respectively, inside the line of the upstream face of the dam. The longitudinal distance between the holes in each row was ten feet, with the holes in the two rows staggered. At the beginning of the work, these holes were drilled with Burleigh drills before the rock was covered with concrete, and were brought up through the concrete by means of 3-in. pipe to the elevation from which they were grouted. Later, after the foundation had been covered and the grouting operations were carried on up the abutments, pipes were set in place at the proper locations, and the holes were drilled, through these pipes, with a diamond drill after a sufficient depth of concrete had been placed around them. The pipes were set in such a way that the grout could flow freely into any seam that might exist between the concrete and the rock.

A line of holes which were left open for drainage was drilled just downstream from the grout holes, and were brought up through the concrete to the floor of the inspection gallery.

Straight sand cement was used for the grouting. It was mixed in the proportions of about 1 part sand cement to 5 parts water, except in a few cases when it was thickened up to about 1 to 3. Pressure for the leakage test and for final application on the grout was obtained from a tank set at an elevation of about 20 ft. above full reservoir.

Before making the leakage test, immediately prior to grouting, each hole was carefully washed out and sounded. As was

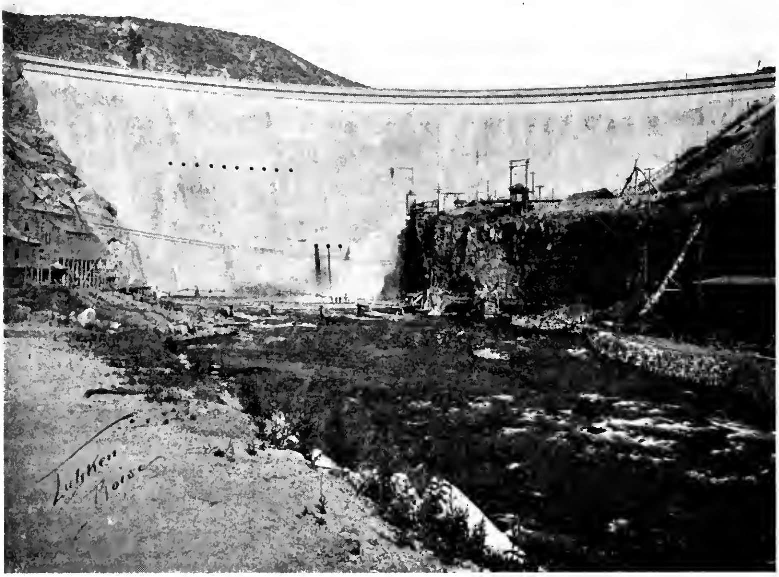

FIG. 5. ARROWROCK DAM.
(Looking upstream.)

Showing water coming through two of the lower outlets. The upper outlets are in plain sight and two of the sluicing outlets may be seen indistinctly, just above water surface

The spillway is at the left beyond the limit of the picture.

expected, most of the holes showed practically no leakage before grouting, but in a few cases an appreciable amount of leakage was detected, and some grout was forced into the rock, although no one hole took any large amount. Generally speaking, however,

the rock took enough grout so that it seemed as if the grouting operations were worth while.

The discharge through the drainage system gave the best evidence of the efficacy of the grouting operations. With water in the reservoir standing within 28 ft. of the top of the dam, or 200 ft. above the lower inspection gallery, the flow through the drainage system was so small as to be negligible.

MEMOIR OF DECEASED MEMBER.

DEXTER BRACKETT.*

DEXTER BRACKETT, past president of the Boston Society of Civil Engineers, died on August 26, 1915.

Mr. Brackett was born on November 30, 1851, in Newton, Mass. He was the only son of Cephas Henry and Louisa Thwing (Pierce) Brackett. His parents removed to Brighton while he

* Memoir prepared by Frederic P. Stearns and Charles W. Sherman.

was yet a child, and Mr. Brackett's education was obtained in the schools of that town. He was graduated from the Brighton High School in 1868, and thereafter took a course at a business college in Boston.

Up to this time he had formed no definite plan as to his future work, but in March, 1869, was offered employment in the office of the city engineer of Boston. The annexation of several adjoining towns and cities to the city of Boston, between 1868 and 1874, resulted in a large amount of work for the engineering department, particularly in the extension of the water works to the annexed districts. Mr. Brackett was soon assigned to the work connected with these extensions and to the rearrangement and reinforcement of the main pipe systems of the city following the great fire of 1872.

Soon after the election of Mr. Joseph P. Davis (honorary member of this Society) as city engineer, in 1873, Mr. Brackett was placed in charge of the engineering work connected with the distribution system of the water works. The question of water waste was soon recognized as of great importance, and as early as 1878 Mr. Brackett, under the direction of Mr. Davis, began a careful study of that problem. Domestic water meters were then expensive and comparatively unsatisfactory, so that the first steps toward the restriction of waste were made by means of inspection, aided by the use of Deacon meters. By these means a very considerable reduction was made in the consumption of water in certain districts of the city. As a result of these studies and investigations, and of others which succeeded them, Mr. Brackett became especially interested in matters relating to the consumption and waste of water, and an authority on these subjects. He presented a paper on these subjects to the New England Water Works Association in 1886, and to the American Society of Civil Engineers in 1895.

In 1895, the State Board of Health of Massachusetts, which was then engaged in the preparation of a plan for the water supply to the Metropolitan District, asked Mr. Brackett to report to it upon the consumption of water in the district at that time and the probable future consumption.

Mr. Brackett's connection with the Boston Water Works was

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BOSTON SOCIETY OF CIVIL ENGINEERS
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PROCEEDINGS

NOTICE OF REGULAR MEETING.

A REGULAR meeting of the Boston Society of Civil Engineers will be held on

WEDNESDAY, NOVEMBER 17, 1915,

at 7.45 o'clock P.M., in CHIPMAN HALL, TREMONT TEMPLE, BOSTON.

Mr. Frank C. Shepherd will present a paper on "The Federal Valuation of the Boston and Maine Railroad." The paper was printed in the October number of the JOURNAL.

S. E. TINKHAM, *Secretary.*

PAPERS IN THIS NUMBER.

"The Arrowrock Dam," C. H. Paul.
Memoir of deceased member.

Contributors are hereby notified that proof will not be submitted to them for examination unless requested before the 10th of the month preceding the month of publication.

SPECIAL NOVEMBER MEETING OF THE SANITARY SECTION.

There will be a special meeting of the Sanitary Section, Wednesday evening, November 24, 1915, in the Society Library, Tremont Temple, at 8 o'clock.

The speaker will be Mr. Harold I. Eaton, chief inspector of the Atlantic County Mosquito Extermination Commission. Mr. Eaton is planning to be in Boston for the holiday, which accounts for the special meeting. The subject will be,

"MOSQUITO EXTERMINATION WORK."

The talk will consist of a brief outline of the history of mosquito extermination in Cuba and Panama, the methods used and the results obtained; the history of mosquito extermination in New Jersey; with results of early studies and experiments; the species of mosquitoes troublesome in New Jersey, and their breeding places; the breeding habits of the house mosquito and the problem it affords cities and towns, and the methods used and results obtained; the salt-marsh mosquito, its breeding habits and extermination methods used; salt-marsh drainage in New Jersey and Atlantic County, and results of the work in New Jersey.

Lantern slides will be used to illustrate the work done in Panama and New Jersey.

Frank A. Marston, *Clerk.*

MINUTES OF MEETING.

Boston, Mass., October 20, 1915.—A regular meeting of the Boston Society of Civil Engineers was held this evening at Chipman Hall, Tremont Temple, and was called to order at 8.10 o'clock by the President, Charles R. Gow. There were 148 members and visitors present.

By vote the reading of the record of the September meeting was dispensed with, and it was approved as printed in the October Journal.

The Secretary reported for the Board of Government the election of the following to membership in the grades named:

Members — Edwin Whitmore Colby, Harold Bryant Barney, Raymond Franklin Bennett, Robert Charles Hunter and Frank Bates Walker.

Associate — Bertrand L. Makepeace.

Junior — James Proctor Allardice.

Mr. C. W. Sherman, speaking for the New England Water Works Association, expressed its appreciation of the courtesy which had been extended to its members in the invitation to be present at this meeting and to join in the excursion this afternoon to Salem and in the dinner at the City Club.

By vote the thanks of the Society were extended to the officials and citizens of Salem, Mass., who contributed so much to the success and pleasure of the excursion of the afternoon to inspect the new construction work of the Salem Water Supply.

The thanks of the Society were also voted to A. G. Tomassello & Son for their generous entertainment of our members at the afternoon excursion.

Mr. William S. Johnson was then introduced and read a paper, illustrated with lantern slides, entitled, "The Water Supply of Salem, Mass." At the conclusion of the reading of the paper, a discussion followed in which President Gow, Mr. Harrison P. Eddy and Mr. Robert Spurr Weston took part.

Adjourned.

S. E. Tinkham, *Secretary.*

APPLICATIONS FOR MEMBERSHIP.

[November 5, 1915.]

The By-Laws provide that the Board of Government shall consider applications for membership with reference to the eligibility of each candidate for admission and shall determine the proper grade of membership to which he is entitled.

The Board must depend largely upon the members of the Society for the information which will enable it to arrive at a

just conclusion. Every member is therefore urged to communicate promptly any facts in relation to the personal character or professional reputation and experience of the candidates which will assist the Board in its consideration. Communications relating to applicants are considered by the Board as strictly confidential.

The fact that applicants give the names of certain members as reference does not necessarily mean that such members endorse the candidate.

The Board of Government will not consider applications until the expiration of twenty (20) days from the date given.

BIGELOW, LYMAN WALDO, Norwood, Mass. (Age 28, b. Norwood, Mass.) From March, 1906, to Jan., 1908, rodman, chainman and transitman with E. W. Bowditch and with L. D. Thorpe, both of Boston; from March, 1909, to Dec., 1911, with Portland Railway, Light and Power Co., Portland, Ore., as transitman, field engineer, etc.; from Sept., 1912, to Jan., 1913, assistant city engr., Oregon City, Ore.; from May to Sept., 1913, with E. Worthington, Dedham, as pipe line inspector; from Oct., 1913, to Jan., 1914, instrument man with Massachusetts Highway Comm.; from March, 1914, to Aug., 1915, instrumentman with George A. Smith, Norwood; from Aug., 1915, to date, in private practice as civil engineer and surveyor. Refers to E. M. Blake, N. L. Hammond, F. M. Hersey and D. W. Pratt.

BROWN, HORATIO WHITTEMORE, Boston, Mass. (Age 22, b. Concord, Mass.) Graduate of Mass. Inst. of Technology, 1915, architectural engineering course. Is now assistant, Dept. of Mechanical Engineering, Mass. Inst. of Technology. Refers to H. W. Hayward, W. H. Lawrence, E. F. Miller, E. F. Rockwood, C. M. Spofford and William Wheeler.

BURRILL, NATHAN CARTER, Boston, Mass. (Age 41, b. Newburyport, Mass.) Student at Mass. Inst. of Technology, 1893–97, civil engineering course. From 1897 to 1904, structural engineer and draftsman with Boston Steel & Iron Co.; from 1904 to date, engineer and estimator with H. P. Converse & Co. Refers to E. P. Bliss, M. M. Cannon, J. E. Carty, F. R. Charnock and F. W. Hodgdon.

COBURN, WILLIAM HASKINS, Lawrence, Mass. (Age 25, b. Boston, Mass.) Graduate of Mass. Inst. of Technology, 1912, civil and sanitary engineering courses. From Sept., 1912, to June, 1913, assistant, Dept. of Civil Engineering, Mass. Inst. of Technology; from Feb. to June, 1913, also assistant instructor, Dept. of Economics; from Sept., 1913, to March, 1914, industrial health inspector; from March to Dec., 1914, deputy commissioner of labor, Mass. Board of Labor and Industries; from March, 1915, to date, sanitary engineer, American Woolen Company. Refers to C. B. Breed, R. A. Hale, J. L. Howard, C. M. Spofford, R. S. Weston and R. M. Whittet.

DUGGAN, JOSPEH RICHARD, Milford, Mass. (Age 21, b. Milford, Mass.)

Senior at Mass. Inst. of Technology, sanitary engineering course. Refers to G. L. Hosmer, J. W. Howard, H. B. Luther and A. G. Robbins.

FEHR, GORDON, Boston, Mass. (Age 21, b. Burghersdorp, Cape Colony, Union of South Africa.) Student for three terms at Royal Technical College of Charlottenburg, Berlin, civil engineering course, and is now senior at Mass. Inst. of Technology, sanitary engineering course. Refers to A. E. Burton, G. L. Hosmer, J. W. Howard and H. B. Luther.

FOSTER, HOWARD LESLIE, Amesbury, Mass. (Age 21, b. Merrimac, Mass.) Senior at Mass. Inst. of Technology. Refers to C. B. Breed, J. W. Howard, Dwight Porter and G. C. Whipple.

GREEN, HOWARD WHIPPLE, Woonsocket, R. I. (Age 22, b. Woonsocket, R. I.) Graduate of Clark College, degree of A.B., 1914; is now student at Mass. Inst. of Technology, sanitary engineering course. Refers to C. B. Breed, G. L. Hosmer, J. W. Howard and G. C. Whipple.

HASTIE, FRANK BOWMAN, Passaic, N. J. (Age 20, b. Rutherford, N. J.) Senior at Mass. Inst. of Technology, sanitary and civil engineering courses. Has had some experience in both field and office work during summer vacations at Mass. Inst. of Technology Surveying Camp, and with borough engineer, Garfield, N. J. Refers to C. B. Breed; G. L. Hosmer, J. W. Howard and A. G. Robbins.

McSWEENEY, THOMAS FRANCIS, Framingham, Mass. (Age 22, b. Marlboro, Mass.) Senior at Mass. Inst. of Technology, sanitary engineering course. From Sept. to Nov., 1911, chainman with B. & M. R. R. on location of proposed Mt. Washington R. R.; from Dec., 1911, to Aug., 1912, rodman and instrumentman on relocation and resurvey of N. Y., N. H. & H. R. R.; during July, 1914, transitman with Hugh Nawn Co.; from June to August, 1915, chainman with B. & M. R. R., on revaluation work. Refers to R. E. Barrett, A. E. Burton, G. L. Hosmer, J. W. Howard, H. B. Luther and C. M. Spofford.

SAVAGE, JOHN DANA, Ashby, Mass. (Age 29, b. Newmarket, N. H.) Graduate of Mechanic Arts High School, Boston, 1903, and student at Dartmouth College, 1904–1905. From 1905 to 1907, rodman and transitman with Met. Park Comm., Boston; from 1907 to 1908, with Royal Securities Corp'n of Canada, as assistant engineer on street railway construction in Camaguey, Cuba; from 1908 to 1911, assistant engineer with Porto Rico Railway, Light and Power Co.; from 1911 to 1914 with Porto Rico Const. Co. of San Juan, as assistant engineer on hydro-electric development; from 1914 to 1915, assistant engineer on water-works construction at Mansfield, Mass.; is now resident engineer on construction of Ashby Reservoir for city of Fitchburg, Mass. Refers to P. M. Blake, G. H. Fernald, D. A. Hartwell, W. F. Learned, C. W. Sherman and P. W. Taylor.

SHORROCK, JOHN WILLIAM, Dorchester, Mass. (Age 23, b. Jamaica Plain, Mass.) Graduate of Tufts College Engineering School, 1915. From June, 1914, to Sept., 1915, rodman for Bay State St. Railway Co., Maintenance of Way Dept.; from April to July, 1915, assistant cement tester for Boston Transit Comm.; from July to Aug., 1915, tracer for Lockwood, Greene

& Co.; from August, 1915, to date, rodman, Maintenance of Way Dept., N. Y., N. H. & H. R. R. Refers to S. L. Conner, H. C. DeLong, F. B. Sanborn, R. C. Smith and P. B. Walker.

Taylor, Charles Norton, Wellesley, Mass. (Age 46, b. Hampden, Me.) Received degree of B.C.E. from Maine State College, 1891, and that of C.E. from Univ. of Maine, 1898. Was for two years with engineering department, city of Newton; has been in private practice for twenty years, chiefly along line of design and construction of water and sewerage systems. Refers to E. M. Blake, H. S. French, F. L. Fuller, C. H. Gannett, N. H. Goodnough and L. D. Thorpe.

Tisdale, Ellis Spence, Needham, Mass. (Age 24, b. Dorchester, Mass.) Graduate of Mass. Inst. of Technology, 1915, sanitary engineering course. During summer of 1914, and for three months during 1915, with U. S. Geological Survey, as topographic aid; is now assistant in Civil Engrg. Dept., Mass. Inst. of Technology. Refers to C. F. Allen, C. B. Breed, A. E. Burton, Dwight Porter, C. M. Spofford and G. C. Whipple.

Upham, Albert Lewis, Woonsocket, R. I. (Age 27, b. Dorchester, Mass.) Graduate of Mechanic Arts High School, 1905. From June, 1906, to Nov., 1907, rodman, instrumentman and computer with C. F. Whitney, C.E., Boston; from Nov., 1907, to May, 1912, rodman, instrumentman and concrete inspector with B. & A. R. R.; from May, 1912, to March, 1913, transitman with C., M. & St. P. Ry.; from May to Nov., 1913, assistant engineer on wash boring and sounding tests with Port Comm. of Seattle, Wash.; from May, 1914, to January, 1915, resident engineer with Mass. Highway Comm.; from March to June, 1915, levelman on valuation work with B. & A. R. R.; is now inspector on street paving with city engineer of Woonsocket, R. I. Refers to R. F. Bessey, A. M. Bovis, F. H. Mills and A. P. Rice.

LIST OF MEMBERS.

ADDITIONS.

Allardice, James P. .... 180 Stetson St., Fall River, Mass.
Bennett, Raymond F. .... 211 Commercial St., Portland, Me.
Cannon, Madison M.,
Care H. P. Converse & Co., 88 Broad St., Boston, Mass.
Connolly, Gregory P. .... Beverly Farms, Mass.
Denley, Alfred N. .... 403 Main St., Winchester, Mass.
Everett, Frederic E. .... 56 Beacon St., Concord. N. H.
Harrington, Walter .... 12 Newbury St., Boston, Mass.
Makepeace, Bertrand L. .... 387 Washington St., Boston, Mass.
O'Connor, James H. .... 52 Bradfield Ave., Roslindale, Mass.

CHANGES IN ADDRESS.

Allen, John E. .... 8 Beacon St., Boston, Mass.
Bigelow, William W. .... Technology Chambers, Boston, Mass.

Bowers, George W. . . . . 3200 Franklin Ave., Cleveland, Ohio
Burnes, George R. . . . . 2 Vinal St., Revere, Mass.
Carter, Frank H. . . . . 13 Western Ave., Cliftondale, Mass.
Dashper, Frederick C.,
"Cremyll," Nettleham Road, Lincoln, Lincolnshire, England.
Eichorn, Frederick C. H. . . . . 306 South St., Jamaica Plain, Mass.
Freed, Charles . . . . 1111 Blue Hill Ave., Dorchester, Mass.
Fuller, Philip E. . . . . 64 Adams St., Tufts College, Mass.
Gallene, Victor J. . . . . 21 Everett St., Charlestown, Mass.
Gladding, Raymond D. . . . . Gladding Place, Fall River, Mass.
Guiney, John A. . . . . 67 East Brookline St., Boston, Mass.
Moore, Lewis E. . . . . . . 270 Mill St., Newtonville, Mass.
Morrill, Frank P. . . . 31 Mellen St., Cambridge, Mass.
Morrill, Fred W. . . . . . 24 Harris St., Waltham, Mass.
Oxnard, Horace W. . Care Chief Engr., A. T. & S. F. Ry., Topeka, Kan.
Rourke, Louis K. . . . . 6 Beacon St., Boston, Mass.
Saville, Thorndike . . . . . . 5 Sumner Rd., Cambridge, Mass.
Stearns, Ralph H. . . . . 661 Westminster St., Providence, R. I.
Sumner, Merton R. . . . . 22 Codman St., Portland, Me.
Whitney, Walter C. . . . . 58 Judkins St., Newtonville, Mass.
Woodbury, Stanley W. . . . . 15 Sixth Ave., Haverhill, Mass.

EMPLOYMENT BUREAU.

The Board of Government maintains an employment bureau for the Society, to be a medium for securing positions for its members and applicants for membership, and also for furnishing employees to members and others desiring men capable of filling responsible positions.

At the Society room two lists are kept on file, one of *positions available* and the other of *men available*, giving in each case detailed information in relation thereto.

Men Available.

331. Age 32. Received technical education from I. C. S. courses. Has had seven years' experience as rodman, transitman and chief of party for civil engineer; has also had some experience with B. & M. R. R. on maintenance of way and relocating work in New Hampshire, Vermont, etc., and with Bay State St. Ry. Co. on underground construction. Will accept position in any line of engineering work. Salary desired, $25 per week.

332. Age 22. Student for two and one-half years at Mass. Inst. of Technology, including course at summer surveying camp. Has had about five months' experience, chiefly as rodman; has done some work as transitman

and some drafting and office work; junior member of B. S. C. E. Desires position as transitman, leveler or on plane table work. Salary desired, $12 per week.

333. Age 27. Student at Franklin Union, civil engineering course. Has had two years' experience with Mass. Highway Commission. Desires position as rodman, timekeeper or tracer. Salary desired, $12 to $14 per week.

334. Age 25. Student at Harvard College for one year and at evening school for four years. Has had six years' experience as rodman, transitman and chief of party on construction work; inspector of concreting, rod-setting, pile driving, etc., on subway work; and as draftsman on studies for Boston Tunnel. Desires position as draftsman, transitman or inspector. Salary desired, $23 per week.

335. Age 21. Has completed three years of civil engineering course at Mass. Inst. of Technology, including two months at summer surveying camp. Has had about six months' experience as estimator and as timekeeper on construction work. Desires position as rodman, instrumentman or assistant superintendent on construction work. Salary desired, $18 per week.

336. Age 29. Has had ten and one-half years' experience; has worked as rodman, transitman, chief of party, foreman, etc.; experience includes one year on hydrographic work. Desires position as surveyor, inspector or foreman. Salary desired, $25 per week.

LIBRARY NOTES.

Recent Additions to the Library.

U. S. Government Reports.

Abstracts of Current Decisions on Mines and Mining, December, 1913, to April, 1915. J. W. Thompson.

Analysis of Natural Gas and Illuminating Gas by Fractional Distillation at Low Temperatures and Pressures. G. A. Burrell, F. M. Seibert and I. W. Robertson.

Application of Theory of Least Squares to Adjustment of Triangulation. Oscar S. Adams.

Bibliography of Chemistry of Gas Manufacture. W. F. Rittman and M. C. Whitaker.

Binders for Coal Briquets. James E. Mills.

Coke-oven Accidents in United States during Calendar Years 1913 and 1914. Albert H. Fay, Ed.

Composition of Natural Gas Used in Twenty-five Cities. G. A. Burrell and G. G. Oberfell.

Explosibility of Coal Dust. George S. Rice.

Houses for Mining Towns. Joseph H. White.

Inflammability of Mixtures of Gasoline Vapor and Air. G. A. Burrell and H. T. Boyd.

Metallurgical Smoke. Charles H. Fulton.

Metal-mine Accidents in United States during Calendar Year 1913. Albert H. Fay, Ed.

Methods of Preventing and Limiting Explosions in Coal Mines. George S. Rice and L. M. Jones.

Mining and Milling of Lead and Zinc Ores in Wisconsin District, Wisconsin. Clarence A. Wright.

Monazite, Thorium and Mesothorium. Karl L. Kithil.

Notes on Miners' Carbide Lamps. James W. Paul.

Permissible Explosives Tested Prior to March 1, 1915. Spencer P. Howell.

Prevention of Accidents from Explosives in Metal Mining. Edwin Higgins.

Primer on Explosives for Coal Miners. Charles E. Munroe and Clarence Hall.

Primer on Explosives for Metal Miners and Quarrymen. Charles E. Munroe and Clarence Hall.

Radium-uranium Ratio in Carnotites. S. C. Lind and C. F. Whittemore.

Rules and Regulations for Metal Mines. W. R. Ingalls and others.

Safety in Stone Quarrying. Oliver Bowles.

Saving Fuel in Heating a House. L. P. Breckenridge and S. B. Flagg.

Smelting of Copper Ores in Electric Furnace. Dorsey A. Lyon and Robert M. Keeney.

Southern Cypress. Wilbur R. Mattoon.

Strength Tests of Structural Timbers Treated by Commercial Wood-Preserving Processes. H. S. Betts and J. A. Newlin.

United States Government Specification for Portland Cement.

What a Miner Can Do to Prevent Explosions of Gas and of Coal Dust. George S. Rice.

State Reports.

Connecticut. Biennial Reports of Highway Commissioner for 1899–1900, 1903–08, 1913–14.

Massachusetts. Problems of Port Development. Edward F. McSweeney.

Municipal Reports.

Boston, Mass. Annual Report of Public Works Department for 1913.

Chicago, Ill. Annual Report of Department of Public Works for 1914.

Fall River, Mass. Report of Watuppa Ponds and Quequechan River Commission, together with Report of Fay, Spofford and Thorndike, Consulting Engineers, 1915.

Newton, Mass. Annual Report of City Engineer for 1914.

Philadelphia, Pa. Plain Talk: Report of Department of Public Works, 1914.

Providence, R. I. Annual Report of City Engineer for 1914.

St. Louis, Mo. Annual Report of Water Commissioner for 1914.

Miscellaneous.

American Society for Testing Materials: Year-Book for 1915.

American Society of Civil Engineers: Transactions, Vol. LXXVIII, 1915.

Canada, Department of Mines: Electro-plating with Cobalt. Herbert T. Kalmus and others.

Elements of Highway Engineering. Arthur H. Blanchard. Gift of John Wiley & Sons.

LIBRARY COMMITTEE.

NEW ENGINEERING WORK.

(Under this head a brief description of new engineering work contemplated or under construction will be presented each month. Engineers and contractors are requested to send descriptions of their work to the Secretary, 715 Tremont Temple, Boston, before 1st of each month.)

United States Government.—NAVY YARD.—Work is in progress on a supply ship.

Commonwealth of Massachusetts.—METROPOLITAN WATER AND SEWERAGE BOARD.—*Water Works.*

Pipe Lines.—About 60 per cent. of the work of laying 14 370 lin. ft. of 60-in. cast-iron pipe in Commonwealth Ave., between Prince St. and the Charles River, in Newton, has been completed. The contractors are Andrew M. Cusack, of Boston, and Charles A. Kelley, of Somerville.

Surface Water Drains.—Work is in progress for laying surface water drains near Spot Pond, Stoneham. The work consists of laying 1 720 lin. ft. of 15-in. vitrified clay pipe, 450 lin. ft. of 12-in. vitrified clay pipe and a paved open channel for about 330 lin. ft. Thomas Russo & Company, of Boston, are the contractors.

Bellevue Reservoir.—The work on the granite masonry tower, which is to enclose the new steel tank (100 ft. in diameter by 44 ft. high) on Bellevue Hill, West Roxbury, is almost completed and the steel work for the roof is in place. John Cashman & Sons Company, of Boston, are the contractors.

METROPOLITAN WATER AND SEWERAGE BOARDS.—*Sewerage Works.*—Work is in progress on Sections 105 and 106 of the Wellesley Extension Sewer and on the temporary outfall for the Deer Island outfall extension.

Plans and specifications for the reconstruction of the Malden River siphon are ready.

METROPOLITAN PARK COMMISSION.—*Charles River Reservation.*—Plans and specifications have been prepared, and it is expected to call for bids in the near future for bridge over the Charles River at North Beacon St., Boston and Watertown.

Plans and specifications are being prepared for bridge over the Charles River at Commonwealth Ave., between Newton and Weston.

Work of excavating channel of Charles River from Elm St. to Bleachery Dam, Waltham, is in progress. John R. Burke, contractor.

Furnace Brook Parkway. — Work of construction of parkway extension from Quincy Shore Reservation to Hancock St. is in progress. John Cashman & Sons Co., contractors.

Work of building reinforced concrete girder bridge across Blacks Creek, for Furnace Brook Parkway Extension, is in progress. Hugh Nawn Contracting Co., contractors.

Mystic Valley Parkway. — Work of excavating the channel of Aberjona River from Boston & Maine Railroad Bridge to Waterfield St., Winchester, is in progress. Coleman Brothers, contractors.

Revere Beach Reservation. — Work of constructing concrete shore protection from Bath House Shelter to Revere Street Shelter is in progress. Coleman Brothers, contractors.

Directors of the Port of Boston. — *Dry Dock.* — The contract for the construction of the dry dock at South Boston awarded by the Port Directors to the Holbrook, Cabot & Rollins Corporation, of Boston, was approved by the Governor and Council on October 13, 1915, and work began immediately.

The construction of the bulkhead and filling of flats adjacent to the dry dock site was completed under previous contracts. The Commonwealth thereby has reclaimed twenty-six acres of flats, and with the completion of the filling back of the dock walls, an additional area of nine acres, making a total of thirty-five acres, will ultimately be available for the necessary repair plants and industries in connection with the commercial use of the dock.

The dry dock when completed will be the largest in the world, having a length of 1 200 ft. and entrance width of 133 ft., and capable of docking the largest ships afloat or projected for many years to come. The dock will rest on bed rock and will be constructed of concrete with a lining of granite.

Plans and specifications are now being prepared for the dry dock pumping plant.

East Boston. — The legislature on March 31, 1915, approved the new harbor lines established by the Directors of the Port of Boston for both East and South Boston, and the U. S. War Department granted its approval on August 10, 1915. These lines are now the basis for further activity in harbor improvements.

Through the establishment of these harbor lines, there is provided an immense area of flats, upwards of 800 acres, which may be reclaimed by the use of such dredged material as may be dredged from Boston Harbor, its rivers and estuaries, either by the state or by private parties.

As a first step in inaugurating this policy of conservation, there has been secured from the Secretary of War permission to close from navigation the old channel northwest of Governor's Island and to dump in that channel, and adjacent territory enclosed within the revised harbor lines, such material as the Directors or other parties may dredge from different parts of the harbor. Since June, 1915, a total of about 300 000 cu. yds. has been dumped there.

A further step is now being taken by the preparation of contracts under which there will be dredged and rehandled over one and a half million cubic yards of material from certain areas adjacent to the present anchorage basin in East Boston and deposited upon the flats of East Boston to reclaim approximately 35 acres adjacent to Jeffries Point. The areas to be dredged are so located that they will ultimately be the docks between piers which may be required for the terminals as outlined on the comprehensive plan of development for the port of Boston.

Dredging. — The Directors have during the past six months made improvements in various minor channels of the harbor by the awards of six contracts aggregating approximately 200-000 cu. yds. of material, a part of which has been dumped at East Boston within the revised harbor lines.

Traffic Investigation. — A study is in progress to determine the quantity and routing of freight moving from the north to the south side of Boston, originating and terminating within

a certain zone surrounding Boston, extending as far as Lowell, Framingham, Walpole, Taunton and Plymouth.

The Port Directors have secured the coöperation of the three railroads, namely, the Boston & Maine, Boston & Albany, and New York, New Haven & Hartford, and they are submitting data regarding the amount of freight interchanged between these several roads. It is hoped that valuable conclusions will be drawn from this study relative to the traffic conditions about Boston.

Boston Transit Commission.—Notes on the status of the work on the Dorchester Tunnel and the East Boston Tunnel Extension were printed in the October issue of the JOURNAL.

City of Boston. — PUBLIC WORKS DEPARTMENT, HIGHWAY DIVISION, PAVING SERVICE. — Work is in progress on the following streets:

Augustus Ave.,	Poplar St. to beyond Clarendon Ave.	Bituminous macadam.
Birch St.,	Penfield St. to Dudley Ave.	Bitulithic pavement.
Bayswater St.,	Saratoga St. to Austin Ave.	Artificial stone sidewalks.
Crandall St.,	Augustus Ave. to Hillside Ave.	Bituminous macadam.
Cushing Ave.,	Windermere Rd. to Jerome St.	Artificial stone sidewalks.
Dane St.,	Holbrook St. to Orchard St.	Asphalt pavement.
Day St.,	Minden St. to Centre St.	Artificial stone sidewalks.
Elgin St.,	Centre St. to W. Rox. Branch R. R.	Asphalt pavement.
Haslet St.,	Amherst St. to Metcalf St.	Bituminous macadam.
Kenney St.,	Day St. to 500 ft. northwesterly.	Asphalt pavement.
Mackin St.,	Waverly St. to Western Ave.	Bitulithic pavement.
Oakland St.,	River St. to Rockdale St.	Bituminous macadam.
Prince St.,	Pond St. to the Arborway.	Asphalt pavement.
Public Alleys 800–10–11,	Batavia St. to Gainsborough St.	Hassam block.
Schiller Rd.,	Rockland St. to the Dedham line.	Bituminous macadam.
Spring St.,	At hospital.	Concrete fence.
Chapin Ave.,	Mt. Vernon St. to Preston Rd.	Bituminous macadam.

The Fore River Shipbuilding Co., Quincy, Mass., has the following work in progress:

U. S. Torpedo Boat Destroyers *Tucker*, Nos. *63* and *64*.

U. S. Submarine Boat *Schley*.

Ten submarine boats for British Navy.

Submarine boat for Spanish government.

Two oil-tank steamers for the Texas Oil Co., *Texas* and *New York*.

Two molasses boats for Cuba Distilling Co., *Cubadist* and *Meleiro*.

Two tank steamers for the Texas Steamship Co.

The Panama Canal may consider this thing a joke, but we wish it would stop its skidding.—*Boston Transcript*.

Vol. II DECEMBER, 1915 No. 10

BOSTON SOCIETY OF CIVIL ENGINEERS
FOUNDED 1848

PROCEEDINGS

NOTICE OF REGULAR MEETING.

A REGULAR meeting of the Boston Society of Civil Engineers will be held on

WEDNESDAY, DECEMBER 15, 1915,

at 7.45 o'clock P.M., in CHIPMAN HALL, TREMONT TEMPLE, BOSTON.

Mr. A. A. Cohill will read a paper on "The Construction of the Dorchester Tunnel under Fort Point Channel." The paper will be illustrated with lantern slides.

Ladies are invited to be present at this meeting.

S. E. TINKHAM, *Secretary*.

PAPERS IN THIS NUMBER.

"The South End Sewer System of Boston," Edgar S. Dorr.
(Presented before the Sanitary Section, November 3, 1915.)

"Laying a Small Cast-Iron Pipe across a Narrow Stream," Charles R. Gow.

"External Corrosion of Water Pipe by Sulphuric Acid," Harrison P. Eddy.

This number of the JOURNAL also contains a title page, table of contents and index for Volume II.

Current Discussions.

Paper.	Author.	Published.	Discussion Closes.
"Federal Valuation of B. & M. R. R."	F. C. Shepherd.	Oct.	Jan. 10
"The Arrowrock Dam."	C. H. Paul.	Nov.	Jan. 10

Contributors are hereby notified that proof will not be submitted to them for examination unless requested before the 10th of the month preceding the month of publication.

In addition to the professional papers presented before the Society, the Journal will hereafter contain one or two brief narratives of interesting engineering experiences of members whenever they are available. They may not exceed a few paragraphs in length, and while of such a nature that they will not be suitable for presentation before the Society, they will nevertheless give valuable information. The first of these short articles appears in this issue of the Journal.

Edward C. Sherman, *Editor.*

MINUTES OF MEETINGS.

Boston, Mass., November 17, 1915. — A regular meeting of the Boston Society of Civil Engineers was held this evening at Chipman Hall, Tremont Temple, and was called to order at 8.15 o'clock by the President, Mr. Charles R. Gow. There were present 79 members and visitors.

By vote, the reading of the record of the October meeting was dispensed with, and it was approved as printed in the November Journal.

The Secretary reported for the Board of Government the election of the following to membership in the grades named:

Members — Clayton Clifford Alexander and Samuel Aubin Nash.

Associate — Theodore Reed Kendall.

Juniors — Willard Gile Burleigh and Thornton Rice Stenberg.

Memoirs of deceased members were presented as follows: That of Past President Dexter Brackett prepared by a committee consisting of Messrs. Frederic R. Stearns and Charles W. Sherman; that of Theodore L. Keppler prepared by Mr. Frederic I. Winslow; and that of Levi G. Hawkes prepared by a committee consisting of Messrs. James E. Stone and Theodore P. Perkins.

By vote, the memoirs were received and ordered printed in the JOURNAL.

The Secretary announced the death of Ernest P. Whitten, a member of the Society, which occurred on June 17, 1915, and by vote the President was requested to appoint a committee to prepare a memoir.

The President reported for the Board of Government its recommendation that an invitation be sent to the American Society of Civil Engineers to hold its annual convention for 1916 in the city of Boston, and that a committee of three be appointed by the President, of which he shall be chairman, to have charge of the matter. On motion of Mr. Fay, the recommendation was adopted by a unanimous vote.

Mr. Frank C. Shepherd then read the paper of the evening, entitled, "The Federal Valuation of the Boston and Maine Railroad." The paper was discussed by Wm. J. Cunningham, assistant professor of transportation at Harvard College; Mr. James C. Irwin, assistant valuation engineer, Boston & Albany Railroad; and Mr. Hammond V. Hayes, consulting engineer, of Boston.

Adjourned.

S. E. TINKHAM, *Secretary.*

BOSTON, MASS., November 3, 1915. — An excursion was held by the Sanitary Section, Boston Society of Civil Engineers, this afternoon, at 5 o'clock, to the new automatic sewage pumping station of the city of Boston, at the corner of Albany and Union Park streets.

The various details of the building and machinery were explained by Messrs. Edgar S. Dorr, Charles H. Dodd and other engineers of the Public Works Department.

There were 64 present.

In the evening, at 8 o'clock, a meeting was held in the Society library, Tremont Temple, at which Chairman Gage presided.

A very interesting illustrated paper on the "South End Sewer System" was read by E. S. Dorr, engineer in charge, Sewer Service, Public Works Department, city of Boston. This system includes the pumping station visited in the afternoon.

There were 32 present at the meeting.

FRANK A. MARSTON, *Clerk*.

APPLICATIONS FOR MEMBERSHIP.

[December 3, 1915.]

THE By-Laws provide that the Board of Government shall consider applications for membership with reference to the eligibility of each candidate for admission and shall determine the proper grade of membership to which he is entitled.

The Board must depend largely upon the members of the Society for the information which will enable it to arrive at a just conclusion. Every member is therefore urged to communicate promptly any facts in relation to the personal character or professional reputation and experience of the candidates which will assist the Board in its consideration. Communications relating to applicants are considered by the Board as strictly confidential.

The fact that applicants give the names of certain members as reference does not necessarily mean that such members endorse the candidate.

The Board of Government will not consider applications until the expiration of twenty (20) days from the date given.

DAVIS, THOMAS C., Newton Highlands, Mass. (Age 40, b. Walpole, N. H.) Graduate of Worcester Polytechnic Inst., 1899, civil engineering course. From 1899 to March, 1900, foreman on sewer construction for City of Worcester; from 1900 to 1904, with Shiffler Bridge Co., which became the American Bridge Co. and then the Pittsburgh Const. Co. during this period; work here included that of designer, estimator and superintendent of construc-

tion; from 1904 to 1911, with various engineering concerns, chiefly as superintendent of construction or on design of steel and concrete; is now employed by Morrison & Young, contractors, Salem, Mass. Refers to C. M. Allen, H. P. Eddy and A. L. Fales.

JOHNSON, FRANK W., Brooklyn, N. Y. (Age 26, b. East Boston, Mass.) Student for three years at Franklin Union, civil and hydraulic engineering courses, and for one year at West Side Y. M. C. A., New York; is now student at Brooklyn Polytechnic Inst., civil engineering course. From 1909 to 1910, draftsman with Orcutt Automatic Train Stop Co., Boston; from April, 1910, to date, assistant designing engineer with Ambursen Co., New York. Elected a Junior, March 19, 1913, and now desires to be transferred to grade of Member. Refers to J. W. Bickford, H. L. Coburn, C. H. Eglee, W. F. Farley and E. H. Rockwell.

PEACOCK, FRANK EDWARD, Rockford, Ill. (Age 20, b. Rockford, Ill.) Student at Mass. Inst. of Technology, civil engineering course; was student at Technology summer surveying camp, July to September, 1915. Refers to C. B. Breed, A. E. Burton, G. L. Hosmer, J. W. Howard and A. G. Robbins.

SNOW, LESLIE WHITMORE, Boston, Mass. (Age 25, b. Snowville, N. H.) Graduate of Dartmouth College, 1912; graduate of Mass. Inst. of Technology, civil engineering course, 1914. Has had five months' practical experience in surveying, and is now with Woonsocket Machine & Press Co. and Ames Plow Co. on system work in plant. Refers to A. E. Burton, W. H. Coburn, A. G. Robbins, G. E. Russell and C. M. Spofford.

SOKOLL, JACOB MAX, New Haven, Conn. (Age 26, b. Kerson, Russia.) Graduate of Tufts College, civil engineering course, 1913. Was employed temporarily after graduation with Water Division, High Pressure Fire Service of Boston; and as structural detailer and draftsman with New England Structural Co.; from Dec., 1913, to date, timekeeper, rodman, engineer and steel foreman with Aberthaw Construction Co. Elected a Junior, December 17, 1913, and now desires to be transferred to grade of Member. Refers to L. H. Allen, S. L. Conner, J. A. Garrod, A. B. MacMillan, E. H. Rockwell and F. B. Sanborn.

LIST OF MEMBERS.

ADDITIONS.

KENDALL, THEODORE R. .... 93 Gainsboro St., Boston, Mass.
NASH, S. AUBIN .... 77 Toxteth St., Brookline, Mass.
STENBERG, THORNTON R. .... 99 Salisbury St., Worcester, Mass.
WHITMORE, HAROLD C. .... 57 Bartlett Ave., Pittsfield, Mass.

CHANGES IN ADDRESS.

BADGER, FRANK S. .... 43 Exchange Pl., New York, N. Y.
BALCH, WM. H. .... 46 Green St., Boston, Mass.

Blake, E. M. . . . . Hyde Park, Mass.
Dolliver, Henry F. 550 Haverhill St., Lawrence, Mass.
Doten, Charles C. . . . . Box 345, Plymouth, Mass.
Herrick, Henry A. . . . . 201 Devonshire St., Boston, Mass.
Hoyt, Laurence B. 168 E. Emerson St., Melrose, Mass.
Jeffers, Robert B. . . . . 121 N. Fitzhugh St., Rochester, N. Y.
Moore, Chester A. . . . . 95 Pennsylvania Ave., Somerville, Mass.
Phelan, John J. 403 G St., Northeast, Washington, D. C.
Raymond, John W., Jr. . . . . 165 Tracy Ave., Lynn, Mass.
Soutar, George P. . . . . 33 Chestnut St., East Lynn, Mass.

DEATH.

Whitten, Ernest P. . . . . June 17, 1915

EMPLOYMENT BUREAU.

The Board of Government maintains an employment bureau for the Society, to be a medium for securing positions for its members and applicants for membership, and also for furnishing employees to members and others desiring men capable of filling responsible positions.

At the Society room two lists are kept on file, one of *positions available* and the other of *men available*, giving in each case detailed information in relation thereto.

Men Available.

305. Age 23. Graduate of Mechanic Arts High School, 1910; is now student in structural course at Lowell Inst. Has had more than three years' experience as draftsman, including one and one-half years with the Edison Electric Illuminating Co.; eight months with General Electric Co. of Lynn; seven months with Swift & Co., in construction department; two months with Aberthaw Construction Co.; and four months with various engineering concerns. Desires position as draftsman or on outside work.

337. Age 27. Received technical education from evening study. Has had eight years' experience, four years of which were spent on design of engineering structures, specializing in reinforced concrete; experience includes field work, inspection, drafting, etc., on railroads, Panama Canal, ocean terminals, reclamation and irrigation. Desires position along engineering lines. Salary desired, $125 per month.

LIBRARY NOTES.

Recent Additions to the Library.

U. S. Government Reports.

Annual Report on Statistics of Railways in United States for 1912–13.

Comparative Railway Statistics of United States and Foreign Countries in 1912.

Distribution of Magnetic Declination in United States for January 1, 1915. Daniel L. Hazard.

Northern Hardwood Forest: Its Composition, Growth and Management. E. H. Frothingham.

Proceedings of Naturalization Reception, Philadelphia, 1915.

Results of Magnetic Observations Made by United States Coast and Geodetic Survey in 1914. Daniel L. Hazard.

State Highway Mileage and Expenditures to January 1, 1915.

Triangulation along Columbia River and Coasts of Oregon and Northern California. Charles A. Mourhess.

Triangulation in West Virginia, Ohio, Kentucky, Indiana, Illinois and Missouri. A. L. Baldwin.

State Reports.

Massachusetts. Annual Report of Highway Commission for 1914.

Ohio. Report of State Board of Health of Study of Collection and Disposal of City Wastes in Ohio, 1910.

Wisconsin. Peat Resources of Wisconsin.

Wisconsin. Annual Reports of Railroad Commission for 1910–13.

Municipal Reports.

Buffalo, N. Y. Corporation Proceedings containing Reports of American Public Health Association and of Rudolph Hering on Purification of Water Supply.

Buffalo, N. Y. Annual Report of Bureau of Water for 1914–15.

Lynn, Mass. Annual Report of Commissioner of Water and Water Works for 1914.

Medford, Mass. Annual Report of City Engineer for 1914.

Minneapolis, Minn. Official Laws Regulating Construction, Alteration, Maintenance, Repair and Removal of Buildings.

New Orleans, La. Report to Sewerage and Water Board on Hurricane of September 29, 1915, and Subsequent Heavy Rainfalls.

Newton, Mass. Annual Report of Street Commissioner for 1914.

Salt Lake City, Utah. Annual Reports of City Officers for 1914.

Salt Lake City, Utah. Appropriation Budget for 1915.

Miscellaneous.

American Society for Testing Materials. Proceedings for 1915. 2 vols.

Bay State Street Railway Company: Report on Property and Business, 1915. Gift of H. S. Knowlton.

Boston Directory, 1914. Gift of W. B. Conant.

Canada, Department of Mines: Electrothermic Smelting of Iron Ores in Sweden. Alfred Stansfield.

Chemical Rubber Company, Cleveland, Ohio: Handbook of Chemistry and Physics, 1914.

Cooling Ponds for Condensing Engines. Lee H. Parker, President Spray Engineering Co.

Great Southern Lumber Company: Select Structural Material.

International Irrigation Congress: Proceedings for 1914.

Keuffel & Esser Company: Catalogue of Drawing Materials, Surveying Instruments, etc., 1915.

Massachusetts Peace Society: Arithmetic of War; America's International Ideals; Practical International Program; Agencies for Promoting World Order. Jay William Hudson.

National Fire Protection Association: Fire Protection in Schools.

New International Encyclopædia, vols. 13 to 16, inclusive.

LIBRARY COMMITTEE.

Among the big uplift movements under way is the filling in of seventy-five acres of Boston Harbor flats now under water. — *Boston Herald.*

NEW ENGINEERING WORK.

(Under this head a brief description of new engineering work contemplated or under construction will be presented each month. Engineers and contractors are requested to send descriptions of their work to the Secretary, 715 Tremont Temple, Boston, before 1st of each month.)

Commonwealth of Massachusetts.—Metropolitan Water and Sewerage Board. — *Water Works.*

Pipe Lines. — About 80 per cent. of the work of laying 14 370 lin. ft. of 60-in. cast-iron pipe in Commonwealth Ave., between Prince St. and the Charles River, in Newton, has been completed. The contractors are Andrew M. Cusack, of Boston, and Charles A. Kelley, of Somerville.

Bellevue Reservoir. — The work on the granite masonry tower, which encloses the new steel tank (100 ft. in diameter by 44 ft. high) on Bellevue Hill, West Roxbury, is completed and the steel work for the roof is in place. About one half of the reinforced concrete floor is laid, and work is started on the terra-cotta walls.

Metropolitan Water and Sewerage Boards. — *Sewerage Works.* — Work is in progress on Sections 105 and 106 of the Wellesley Extension Sewer and on the temporary outfall for the Deer Island outfall extension.

The contract for the reconstruction of the Malden River siphon has been awarded.

Plans are nearly ready for Sections 103 and 104 of the Wellesley Extension Sewer.

Metropolitan Park Commission. — *Charles River Reservation.* — Bids have been received for building reinforced concrete bridge over the Charles River at North Beacon St., Boston and Watertown, and the contract awarded to A. G. Tomasello, the lowest bidder.

Plans and specifications are being prepared for bridge over the Charles River to Commonwealth Ave., between Newton and Weston.

Work of grading, surfacing and other work from Charlesbank Road to Brooks St., Newton and Boston, is in progress. Rowe Contracting Co., contractor.

Work of excavating channel of Charles River from Elm St. to Bleachery Dam, Waltham, is in progress. John R. Burke, contractor.

Furnace Brook Parkway. Work of construction of parkway extension from Quincy Shore Reservation to Hancock St. is in progress. John Cashman & Sons Co., contractor.

Work of building reinforced concrete girder bridge across Blacks Creek for Furnace Brook Parkway Extension is in progress. Hugh Nawn Contracting Co., contractors.

Mystic Valley Parkway. — Work of excavating the channel of Aberjona River from Boston & Maine Railroad bridge to Waterfield St., Winchester, is in progress. Coleman Brothers, contractors.

Revere Beach Reservation. — Work of constructing concrete shore protection from Bath House Shelter to Revere Street Shelter is in progress. Coleman Brothers, contractors.

DIRECTORS OF THE PORT OF BOSTON. — *Dry Dock.* — The work under the contract with the Holbrook, Cabot & Rollins Corp. for the construction of the dry dock at South Boston is in progress. The contractor is assembling the plant and at the present time is dredging the dry dock site at the rate of 5 000 cu. yds. of material per day.

East Boston. — The Directors received bids on November 24, 1915, for two contracts, one for building a bulkhead and filling around the same and the other for dredging and filling on state flats at East Boston. The contract for bulkhead and filling was awarded by the Directors on November 29 to the Bay State Dredging and Contracting Co. Under this contract there will be constructed about 2 200 lin. ft. of bulkhead and about 170 000 cu. yds. of filling. Bids were received also from Coleman Bros. and from H. P. Converse & Co. The prices

submitted for the bulkhead ranged from $21 to $23.94 per lin. ft. of bulkhead. Prices for filling varied from 18.7c to 41.5c per cu. yd.

The bulkhead will extend easterly from the end of Maverick St. and be constructed of 6-in. yellow pine sheeting and oak piles in bents 6 ft. apart, one vertical pile and two spur shore piles in each bent. Filling is to be placed on both sides of the bulkhead to an elevation of 10 ft. above mean low water, leaving at this elevation a berm 10 ft. wide on both sides and allowing the material to take its natural slope.

Only one bid was received for the other contract, namely, that of H. P. Converse & Co., for dredging and filling, involving the handling of about 1 500 000 cu. yds. of material.

Dredging. — During the past month there has been dredging under contracts by the Directors of about 20 000 cu. yds. of material for the improvement of minor channels in the harbor. The Directors are receiving proposals for leasing of a large suction dredging plant for use in Boston Harbor.

South Boston. — The Directors propose to grade D St. between Fargo and Egmont streets and install a sewer in Fargo St. between C and D streets, South Boston.

Boston Transit Commission. — *Dorchester Tunnel.* — Section D, including the station in Dewey Square, which is to be known as "South Station Under," the Hugh Nawn Contracting Co., contractor for all heavy work, is practically done. The work of finishing the interior of the station with tile, terrazzo and white cement plaster remains to be done and is now in progress.

Section E was described in the October JOURNAL, p. 9*. The shield for the easterly tunnel, which was started first, is half way between West First St. and Summer St., and the westerly tunnel shield is just going under the water. P. McGovern & Co. is the contractor.

Section G is located in Dorchester Ave. between West Fourth St. and Old Colony Ave., and is about 1 280 ft. long. The structure is to be mainly of reinforced concrete. The work includes a pump well with an emergency exit, a ventilating chamber with an emergency exit, an open incline for surface

cars, a 6 ft. 6 in. tidegate chamber on the B St. outfall sewer, and sewer changes. Coleman Bros. are the contractors.

Section H is located in Dorchester Ave. and extends from Old Colony Ave. to within about 300 ft. of Andrew Square. The structure is to be mainly of reinforced concrete, and consists of a single-span double-track tunnel excepting for about 200 ft. at its southerly end, where a middle wall will separate the tracks in the tunnel, all to be built by the cut-and-cover method. The work also includes a pump well, an emergency exit and sewer changes. The excavation has been nearly completed. The T. A. Gillespie Company is the contractor.

East Boston Tunnel Extension. — The Commission's work on the East Boston Tunnel Extension is practically completed, with the exception of the Otis inclined escalator, leading to the street surface in Scollay Square, which is being installed for the "Scollay Under" Station.

City of Boston. — Public Works Department, Highway Division, Paving Service. — Work is in progress on the following streets:

Gladstone St.,	Walley St. to Upland St.	Artificial stone sidewalks.
Mackin St.,	Western Ave. to Waverly St.	Bitulithic.
Chapin Ave.,	Mt. Vernon St. to Preston Rd.	Tar macadam.
Prince St.,	Pond St. to the Arborway.	Asphalt.
Dane St.,	Holbrook St. to Orchard St.	Asphalt.
Elgin St.	Centre St. to W. R. Branch R. R.	Asphalt.
Glendower Rd.,	Kittredge St. to Poplar St.	Asphalt.
Montebello Rd.,	Forest Hills St. to Walnut Ave.	Bitulithic.
Spring St.,	At hospital grounds.	Fence.
Oakland St.,	River St. to Rockdale St.	Asphalt macadam.
Jones Ave.,	Mascot St. to Ballou Ave.	Asphalt.
Rosewood St.,	Oakland St. to Randolph Rd.	Asphalt.
Creighton St.,	Centre St. to Day St.	Artificial stone sidewalks.

The Fore River Shipbuilding Co., Quincy, Mass., has the following work in progress:

Twenty-seven submarine boats.

Oil tankers *Texas* and *New York.*

Cargo vessel *Cubadist.*

Freight steamers *Edward Luckenbach* and *Julia Luckenbach.*

Molasses steamers *Sucrosa* and *Mielero.*

Two freight steamers for the Texas Company.

continuous until 1895. During a portion of this time he was superintendent of the eastern division of the Boston Water Works, reporting to the Boston Water Board, and during the remainder of his service, assistant engineer in the city engineer's department, having particularly to do with the work relating to the water works.

Upon the formation of the Metropolitan Water Works, in 1895, Mr. Brackett was selected as engineer of the distribution department, having charge of the piping system, pumping stations and distribution reservoirs for the Metropolitan Water District.

In 1907, upon the resignation of Mr. Frederic P. Stearns, Mr. Brackett was chosen as chief engineer of the Metropolitan Water Works, which position he held to the time of his death. The greater part of the water works had been constructed prior to 1907, so that in this position Mr. Brackett had to do mainly with maintenance and operation. During his term of service, the general introduction of water meters within the Metropolitan District has been undertaken, largely as a result of his persistent advocacy of their use, and they have accomplished the result which Mr. Brackett predicted for them. In addition to the work of maintenance, however, important additions to the works were made or designed during his service as chief engineer, among which may be particularly mentioned the hydro-electric plant at the Wachusett Dam in Clinton; the 40-million gallon high-service pumping engine at Chestnut Hill; the 60-in. cast-iron pipe line from Weston to Chestnut Hill Reservoir, including the pressure tunnel through a hill in Newton; the improvement of the water supply for the elevated districts in Boston, Hyde Park and Milton, including the pumping station at Hyde Park and the steel tank on Bellevue Hill, 100 feet in diameter and 45 feet high, surrounded by a masonry tower; and the hydro-electric plant at the Sudbury Dam in Southboro, now in process of construction.

In addition to his work for the city of Boston, Mr. Brackett was employed in a consulting capacity in connection with water supplies at Fall River, Stoughton, Taunton, New Bedford, Ashburnham and Springfield, Mass.; Auburn, Me.; Syracuse,

N. Y.; Atlantic City, N. J.; Louisville, Ky.; Springfield, Mo.; Harbor Springs, Mich., and various other places, in several cases in connection with the testing of pumping engines or the valuation of the works. After 1895, however, he declined any further engagements outside of his regular work, as the latter made such demands upon his time and strength that it seemed impracticable for him to carry anything additional.

Mr. Brackett's term of service with the Boston and Metropolitan Water Works covered forty-six years, during most of which time he occupied positions of great responsibility. Since the work of the Metropolitan Water Board was in large measure a continuation of that of the old Boston Water Works, it is fair to consider Mr. Brackett's professional life as having been spent in one employ, — a decidedly unusual record, — and the value of the public service which he rendered in this period was certainly very great.

Mr. Brackett took an active interest in the technical societies to which he belonged. He joined the Boston Society of Civil Engineers on June 8, 1874, and was its vice-president in 1895–1897, and its president in 1897–1898. He took a prominent part in the New England Water Works Association, and was its president in 1889–1890. He was a director of the American Society of Civil Engineers in 1908–1910, and a member of the American Water Works Association and of the Boston City Club.

Mr. Brackett had a large circle of firm friends, both inside and outside of the profession.

He was married, in 1875, to Miss Josephine Dame who, with one son, survives him.

Vol. II DECEMBER, 1915 No. 10

BOSTON SOCIETY OF CIVIL ENGINEERS
FOUNDED 1848

PAPERS AND DISCUSSIONS

THE SOUTH END SEWER SYSTEM OF BOSTON.

By Edgar S. Dorr,* Member Boston Society of Civil Engineers.

(Read before the Sanitary Section, November 3, 1915.)

The problem of the relief of the South End Sewer System was a peculiar one. The territory which suffered from bad sewerage conditions, containing about 190 acres, is bounded roughly by Dedham, Tremont and Northampton streets, the N. Y., N. H. & H. Railroad, Tremont and Dover streets, and the South Bay. It is flat and is laid out on the alleyway plan; the streets are graded at about elevation 17, the alleys are generally lower than the streets — in some places 6 or 7 ft. lower — back yards are at the level of the alleys or lower, and basement kitchens and dining rooms are at the yard level. Some of these basements are as low as grade 6, many at 7, and large numbers between 7 and 9.

The sewer system is on the combined principle, delivering its dry-weather flow into the East Side Intercepting Sewer in Albany St., and its storm water flow into the South Bay. When it is considered that the intercepter can carry away only a small fraction of the storm run-off of this acreage, and that mean high tide is elevation 10, mean spring tide elevation 12,

Note. Discussion of this paper is invited, to be received by Edward C. Sherman, Editor, 6 Beacon Street, Boston, before February 10, 1916, for publication in a subsequent number of the Journal.

* Office Engineer, Sewer Div., Dept. of Public Works, Boston.

and still higher tides not infrequent, it will be realized that this district, with its peculiar arrangement and grading of streets, alleys, yards and basements, could hardly have been planned more effectively to produce trouble if it had been done intentionally.

Of course, it was not so done. How, then, did it come about?

To answer this question it is necessary to go into history. It is interesting, however, to trace this peculiar development as it is an example of what serious evils result from the growth of cities without any general plan.

In the beginning, the South Bay and the Back Bay, both areas of flats covered at high water, nearly met, being separated only by the narrow strip of land called Roxbury Neck, with its one road, Washington St. The filling of the flats naturally proceeded both ways from Washington St. Very early came the water-power project, with the milldam damming off the Back Bay from Charles River and furnishing power for tide-mills. Tide-mills cannot run at high tide, and to obviate the trouble a cross-dam was built, dividing the mill pond into two parts, one of which was kept empty, or as nearly so as possible, and used to discharge the water from the other into during the period of high tide in the river, in this way permitting the tide-mills to run full time.

Beacon St. occupies the site of the mill-dam and Hemenway St. that of the cross-dam. The part of the mill pond west of Hemenway St. was called the "Full Basin"; that between Hemenway, Pleasant and Charles streets was called the "Receiving" or "Empty Basin."

All the sewerage troubles of the South End have arisen from the creation of this Empty Basin and its effect upon the development of the adjacent land. The elevation of the water surface was kept at or below elevation 3 at all times. This made of the basin a huge storage reservoir, protected from high tides and affording a low outlet for the sewers which were built to drain the land made by filling the flats. This condition fostered a cheap development. Filling was saved by grading alleys, yards and basements at a low elevation, and no flooding

resulted to check this tendency, as would have been the case if the sewers had been subject to tidal influence. Inasmuch as the Empty Basin was regarded as permanent, this course of events was perfectly natural.

The Basin, satisfactory as a safeguard against floods, was not so satisfactory from a sanitary point of view. We learn from the report of the Committee on Sewers of 1868, consisting of Joseph F. Paul, Newton Talbot and Moses Fairbanks, that it became "evident that this stagnant basin was becoming a gigantic cesspool, and that some plan must be devised for diverting the drainage from it. Accordingly, in 1850–51 a large sewer was built, under plan of Messrs. Chesborough and Parrett, running the whole length of Tremont St., intercepting the outlets of the cross-sewers, and thence down Dover St. to the South Bay. . . . When a heavy rain occurred, however, during this interval (i. e., during high tide), it was arranged to discharge this extra water as before into the Back Bay, by overflows or weirs left for that purpose, and so keep down the level in the sewers."

It is evident from the above quotation that the main reliance for protection against flooding was still placed on the Empty Basin.

The filling of the whole Back Bay, including the Empty Basin, began about 1860, and was in rapid progress in 1862. The disastrous effect that this would have upon sewerage conditions in the South Bay was not unforeseen, as is shown by the building, in addition to the Tremont and Dover streets sewer, of large storage sewers in East Dedham St. in 1857, Union Park St. in 1865, and East Concord St. in 1869, all draining into the South Bay. In short, the plan of turning the drainage of the whole district from the Back Bay to the South Bay was adopted, and to build the main sewers large enough to afford some storage at times of high tide. This is really about all that could be done, short of establishing a pumping station, or raising the whole district bodily, buildings, streets and all. This was done in two instances; the Church St. district, 15 acres, was raised in 1868–1869, at a gross cost of $1 183 363. The sale of the estates after the improvement realized $222 291, making the

net cost to the city $960 441. The Suffolk St. District, 34 acres, was raised in 1870–72, at a gross cost of $2 248 986 and a net cost of $1 565 566.

Other large expenditures occurred about the same time, $1 584 251 for the razing of Fort Hill in 1869–72, and the heavy loans on account of the great fire, $404 674 in 1872, and $5 000 000 in 1873. These were large sums for the City of Boston in the '70's, and these expenditures probably had much to do with the subsequent disinclination of the City Government to attack the larger problem of the South End in general. The condition of these two districts was considerably worse than that of the rest of the South End, as is easily seen from their location in reference to the Empty Basin.

With the completion of the filling of the Back Bay, including the Empty Basin, all hope of relief from this direction ceased; the South End was left a flat area, draining its storm water into the South Bay, under tidal conditions, and so graded that its lowest portions were situated at the upper ends of its sewer systems, 4 000 ft. from the outlets into the South Bay. (Fig. 1.)

Floodings were the inevitable result. While the sewer system was adequate to discharge the storm water of quite heavy rains, provided they occurred at low tide, and its storage sewers had capacity to store the run-off of very short violent showers at high tide, whenever a heavy rain lasted over a high tide, the storm water, polluted with sewage, unable to flow into the South Bay without rising to an elevation higher than the tide, was stored in the low basements, yards and alleys until the next low tide, when it was discharged.

The only thing which was done by the city to alleviate this condition, up to the time of the building of the low-level pumping system about to be described, was the building of the intercepting system, or "Improved Sewerage," so called. This was completed in 1884. The amount of assistance that this system can render is limited to the capacity of the East Side Intercepter in Albany St. The capacity of this sewer running full is about 61 sec.-ft. The storm water run-off of the South End is approximately 500 sec.-ft. It is evident that the most this sewer could do, with all flow from above Dover St. shut off by a regulator,

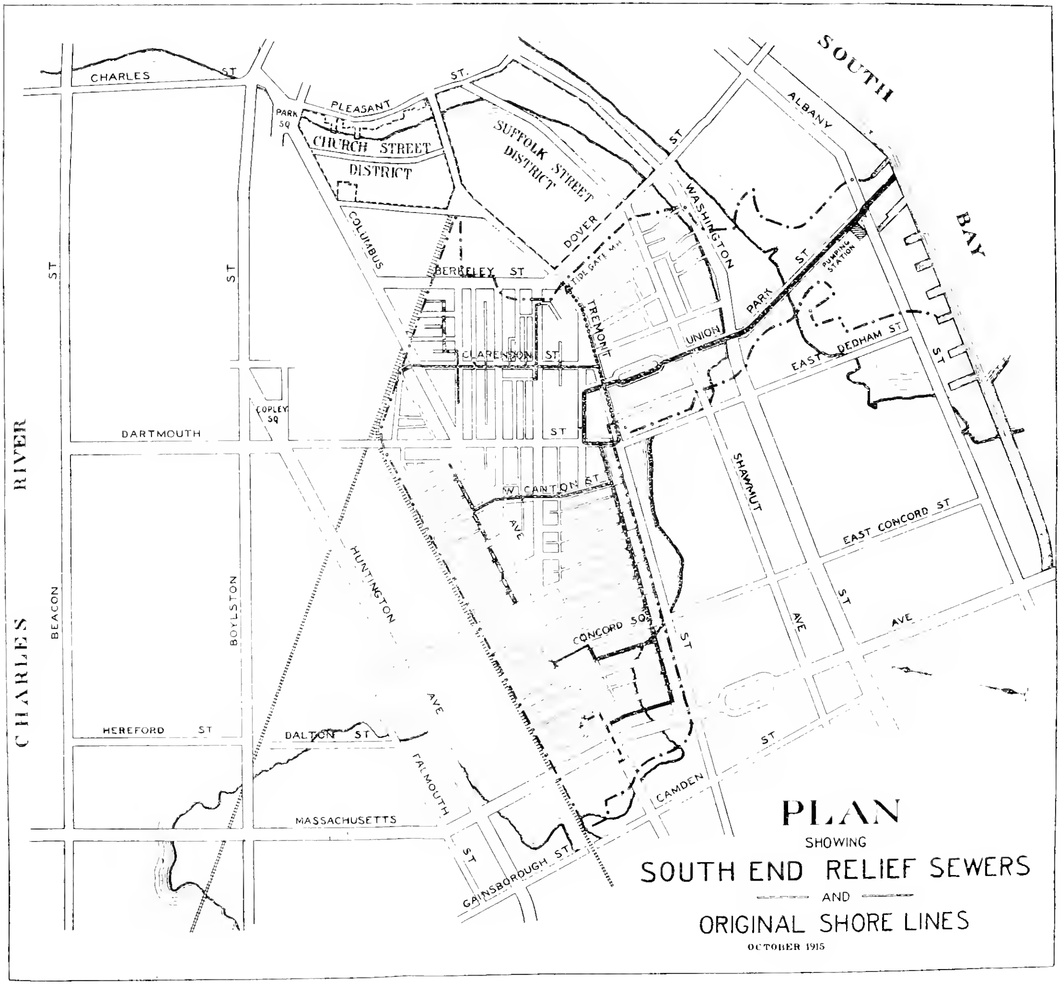

CHARLES ST
PLEASANT ST.
PARK SQ
CHURCH STREET DISTRICT
SUFFOLK STREET DISTRICT
SOUTH BAY
ALBANY
WASHINGTON ST
DOVER
COLUMBUS
BERKELEY ST
TIDE GATE M.H.
TREMONT
PARK ST
PUMPING STATION
UNION
EAST DEDHAM ST
CLARENDON ST
COPLEY SQ
DARTMOUTH ST
W. CANTON ST
AVE
SHAWMUT
EAST CONCORD ST
CHARLES RIVER
BEACON ST
BOYLSTON ST
HUNTINGTON AVE
CONCORD SQ
ST
AVE
ST
AVE
HEREFORD ST
DALTON ST
FALMOUTH
MASSACHUSETTS
CAMDEN
ST
GAINSBOROUGH ST
PLAN
SHOWING
SOUTH END RELIEF SEWERS
AND
ORIGINAL SHORE LINES
OCTOBER 1915

FIG. I.

would be to take care of some small storms, keep the level of the sewage in the system down somewhat below what it would otherwise be in large storms and in some cases drain down the whole system before the tide could do it, when rain would cease a considerable time before low tide, and thereby reduce flood damages somewhat. But it could not prevent flooding. It was, however, used for all it was worth by giving open connections from the Dover and Dedham streets systems into the intercepter, because these were the lowest districts.

With the exception of the limited assistance rendered by the intercepting system, the South End has remained in the condition in which the filling of the Back Bay left it, in 1870, up to July 1, 1915, when the pumps were put in operation for the first time, during the phenomenal downpour of that date.

By the way, not a single complaint was received from the South End on account of that storm, although the tide ranged from elevation 9.40 to elevation 6.50 during the heaviest downpour.

During all this time there have been innumerable complaints and many investigations, but nothing done until recently, and the reason is that every investigation has led to the same conclusion as that reached by the Sewer Committee of 1868, previously referred to, — i. e., that nothing really effective could be done except by pumping.

In old times this could mean nothing less than a steam pumping station, and one particularly difficult and expensive to maintain, on account of the intermittent character and irregularity in time of the service to be required of it. Inasmuch as a rain heavy enough to call it into action is liable to occur at any time, day or night, the station would have to be kept with banked fires and steam up at all times. This would require three shifts of men every twenty-four hours, and yet they would be idle the greater part of the time, sometimes for weeks together.

The cost of installing an adequate station was estimated by the Sewer Committee of 1868 at $200 000.

These conclusions seem to have effectively prevented any action.

The perfection of centrifugal pumps and electrical machinery

and the establishment of reliable sources of electrical energy made a resort to steam unnecessary, and the station recently completed has been designed to be electrically driven and automatically controlled throughout. The starting and stopping of the pumps is governed by the height of the sewage, and very little attendance, comparatively, will be required.

When the problem came to be taken up seriously by the Sewer Division, various expedients were considered. It was evident at once that a resort to the separate system would do no good for, because of the peculiar grading of the district, flooding would have continued from the rain falling on the area of low yards and alleys enclosed between the streets, even after the cellars and basements had been connected with a system of sanitary sewers running to the intercepter.

It was also suggested that by throwing a dam across Fort Point Channel and excluding the tide, the South Bay could be made to serve the same purpose that the Empty Basin had. If the water level could be held down to an elevation between 5 and 7, the existing sewers would be adequate to drain all the South End except the Union Park St. area, which even then would require pumping, but with a low powered station. The objections were many but not insuperable. The dam would have had to be furnished with a lock, and it would have been an impediment to navigation, but not a serious one. The channel, the dock and a part of the bay would also have had to be dredged to restore the same depth of water at the permanent low level as is now enjoyed at high tide.

But the most serious objection was that the whole bay would become a huge sewage pool, from the overflows of the combined sewers, just as the Empty Basin had become. This condition would call for some provision for flushing out and changing the water. This requirement could be met by throwing a dam across Old Harbor, creating a reservoir of clean sea water, which, if conducted through a conduit of adequate size, would have served to replace the polluted water of the South Bay. It would be quite feasible to do this, the flow from the Old Harbor reservoir through the conduit to the South Bay and out through Fort Point Channel to be established at such times as the harbor

tide was below the fixed height of water in the South Bay. Indeed, a plan for doing just this has been prepared and a report made as an alternative to the plans proposed by the special commissioners on the condition of the Old Harbor, the essential feature of the report of the Sewer Office being that the problems of the unsanitary condition of the Old Harbor and the South Bay should be solved together in this way, and that such joint solution would be more economical than to attempt to solve the two problems separately. It is not improbable that this may yet be done, on account of the condition of the South Bay, which, even now, under tidal conditions, is little better than a pool of sewage. If this does happen, little will have been lost, the only difference being that a smaller pumping station would have sufficed.

This scheme evidently was developing into too large a proposition to be immediately practicable; and there was also the uncertainty as to the final disposition to be made of the South Bay, one proposition rather strongly supported being to fill it all up. This does not seem to be at all probable in view of the great value of this canal to the business interests of the city, but the possibility was enough to put a damper on a scheme so comprehensive as to include the Old Harbor, the South Bay and the South End sewerage. Inasmuch as some pumping would have had to be done in any event, it seemed the part of wisdom to lay out a pumping system to relieve the worst parts of the sewer system, and leave the larger problems for solution later.

The sewer systems of the South End are four in number, the mains lying in Dover, Union Park, East Dedham and East Concord streets. The drainage areas are not very distinctly defined on account of the numerous cross connections which have been made from time to time, apparently in efforts to relieve one locality at the expense of another. Two of these districts, Dover and Dedham streets, were especially favored by having open connections with the intercepter in Albany St., that is, there were no regulating valves interposed upon their connections with the intercepter, giving to these districts the benefit of the full capacity of the intercepter.

The Dover, Dedham and Union Park streets system had

overflow outlets of reasonable size from Albany St. to the South Bay; that of Concord St. was very inadequate, being only 4 ft. by 4 ft., whereas the Concord St. sewer was 5 ft. by 8 ft.

The first work done for the relief of the South End was to rebuild this outlet of ample size, 6 ft. 9 in. by 7 ft. 9 in. This was done in 1912. It was hoped that this enlargement of outlet, together with the connection of the worst portions of the system with the pumping system, would improve conditions enough to obviate the necessity of building a pumping station on the Concord St. system, and results so far seem to justify that hope.

The policy to be followed was plain. Only those portions of the district which suffered most from flooding were to be reached by a low level system of sewers connected to a pumping station, while all those portions of the district high enough to drain by gravity were to continue so to drain, thus minimizing the amount of water to be handled by the pumps.

The district being already completely sewered, all of the existing sewers which drained areas high enough to drain by gravity were to be continued in service, and also all the sewers in the low alleys which were large enough and in fair condition were to be utilized by giving them a free outlet into the pumping system. (Fig. 1.)

Levels were taken all over the district in the cellars, basements, yards and alleys, and inquiries made as to floodings. The area finally blocked out for service by the new system included all of the Union Park St. area, a part of the Dover St. area bounded approximately by Tremont, Dover, Groton, Washington and Union Park streets and the upper or northwesterly portions of the Dedham and Concord streets areas — roughly, those portions lying northwest of Tremont St., between Northampton and Dartmouth streets, and extending northwesterly from Tremont St. about half way to Columbus Ave. and Warren Ave.

The total area to be served corresponds curiously well with the outlines of that part of the Empty Basin which lay to the east and south of the N. Y., N. H. & H. Railroad.

The first plan attempted was to drain into the main intercepting sewer in Massachusetts Ave., which would have sent

the flow to the Moon Island outlet. A pumping equipment of low power only would have been required. The lift would have been low and it would have worked only when the water in the main was too high to allow gravity drainage from the new projected system.

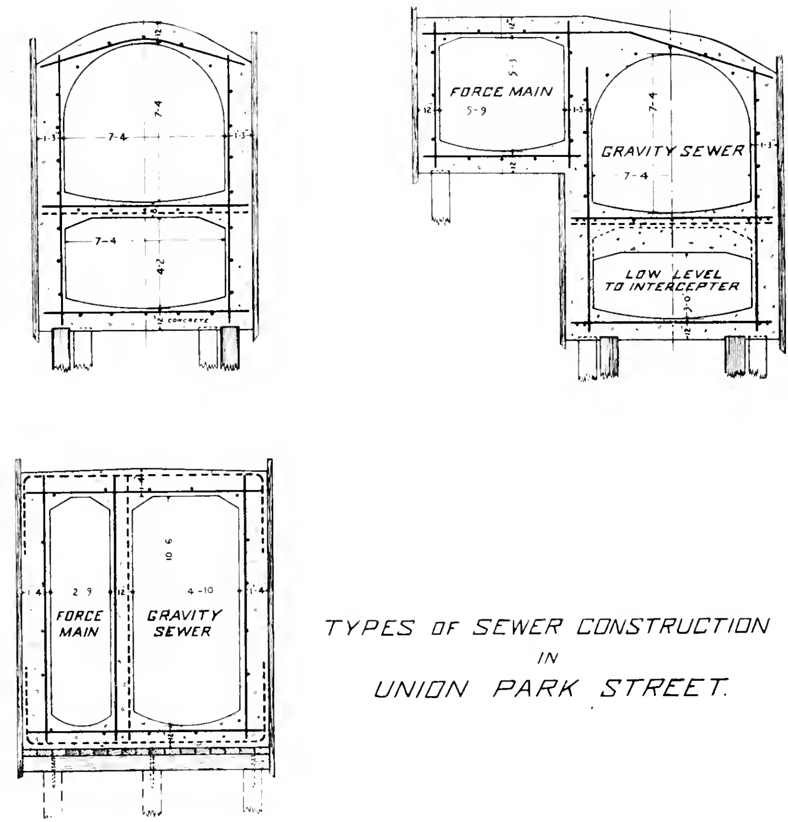


FIG. 2.

The system of sewers was planned, but as the scheme was developed it was perceived that the quantity of water to be thrown into the main would be more than it and the Calf Pasture Pumping Station could handle without imperiling their other function of holding down the level of sewage in the Dover and

Dedham streets districts, and also the Church St. district, which has a similar open connection with the West Side Intercepter. This plan was therefore abandoned, and no other alternative remained except to pump into the South Bay.

This is a less desirable outlet than Moon Island. To divert the flow to Moon Island would have improved the condition of the South Bay, but on the other hand to continue to discharge into it is no detriment because no more polluted water will be discharged into it than formerly. The same quantity will be discharged into it, but in less time.

With the direction of flow of the projected low-level system of sewers determined to be toward the South Bay, the next step was to select a line for the location of the main. Of the four main sewers of the South End, Dover, Dedham, Concord and Union Park streets, the first three were in fairly good condition, but a large part of the Union Park St. sewer was of wood and in rotten condition. For this reason, and also because it was the most direct line to the areas requiring relief, it was determined to rebuild this sewer, and to put in, in the same trench and on the same foundation, the mains for both the low-level and the high-level systems which the district would require. From the outlet nearly to Washington St., pile foundation was required, and to get the whole structure on one foundation, and to minimize excavation, a peculiar section was designed, which might be called a sewer with a horizontal septum; or one sewer superimposed upon another. (Fig. 2.) The top sewer takes the flow from all street surfaces, front roofs and all other parts of the district high enough to drain by gravity, while the lower sewer drains all those portions which will not drain by gravity at high tide and connects with the pumping station. (Fig. 3.)

The top sewer is built at about the same elevation as the old sewer which it replaces, discharges its dry-weather flow into the intercepter in Albany St. through a sump and regulator, and its storm flow through an overflow outlet to the South Bay when the intercepter is full; operating in all respects the same as the old sewer.

The low-level sewer lies underneath the top sewer, connects with the intercepter and discharges its dry-weather flow into it

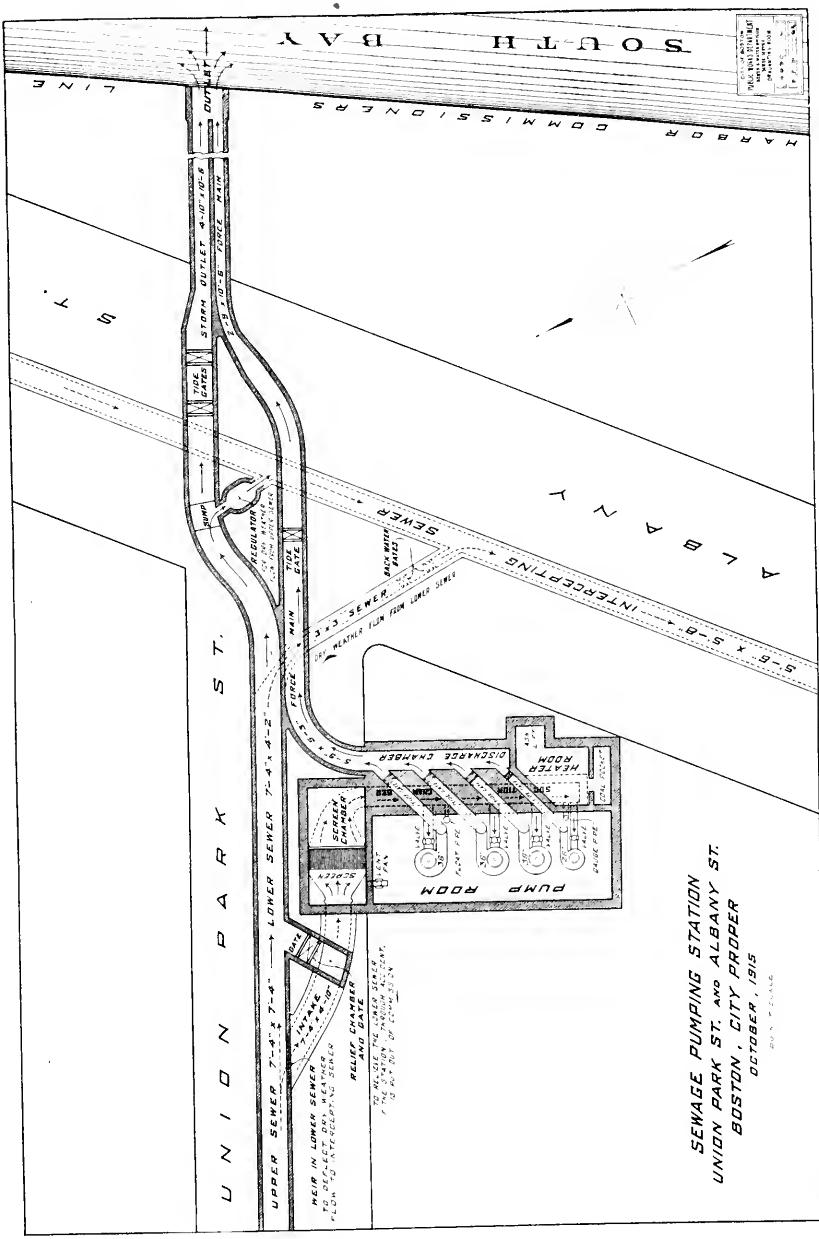

SOUTH BAY
HARBOR COMMISSIONERS LINE
OUTLET
STORM OUTLET 4'-10" x 10'-6"
2-9' x 10'-6" FORCE MAIN
TIDE GATES
ALBANY ST.
SUMP
REGULATOR FOR DRY WEATHER FLOW FROM UPPER SEWER
TIDE GATE
MAIN
BACK WATER GATES
3'x3' SEWER
DRY WEATHER FLOW FROM LOWER SEWER
INTERCEPTING SEWER
5'-9" x 5'-9"
FORCE
5'-3" x 5'-9"
DISCHARGE CHAMBER
HEATER ROOM
ASH LIFT
COAL POCKET
SUCTION CHAMBER
SCREEN CHAMBER
SCREEN
VENT FAN
FLOAT PIPE
GAUGE PIPE
VALVE
PUMP ROOM
UNION PARK ST.
LOWER SEWER 7'-4" x 4'-2"
UPPER SEWER 7'-4" x 7'-4"
LOWER SEWER
GATE
INTAKE 7'-8" x 4'-10"
RELIEF CHAMBER AND GATE
WEIR IN LOWER SEWER TO DEFLECT DRY WEATHER FLOW TO INTERCEPTING SEWER
TO RELIEVE THE LOWER SEWER IF THE STATION THROUGH ACCIDENT IS PUT OUT OF COMMISSION
SEWAGE PUMPING STATION
UNION PARK ST. AND ALBANY ST.
BOSTON, CITY PROPER
OCTOBER, 1915

FIG. 3.

as long as the intercepter will receive it. When the intercepter fills and begins to backflood it, a tide-gate closes and diverts the flow over a weir into the pump-wells of the pumping station, whereupon the pumps start up automatically and eject it into the South Bay through an outlet conduit separate from the overflow outlet of the sewer. The low-level line of main sewer consists of the following sizes:

873 linear feet of 7′ 4″ x 4′ 2″; 903 feet of 7′ 0″ x 4′ 2″; and 677 linear feet of 6′ 5″ x 4′ 2″.

With elevation 1.00 at the weir and 5.00 at Tremont St., the capacity of the portion between Albany St. and Harrison Ave., 873 ft. in length, is about 167 sec.-ft., and this amount was used for the design of the pumps.

If elevation 5.00 be retained at Tremont St. and the flow pumped to elevation 1.29 at the pumps, or about 1.59 at the weir, a maximum of 140 sec.-ft. can be carried from Tremont St. through the whole line with varying gradients.

Assuming all connections with contiguous sewer systems to be cut off, the present area draining into the low-level system at or above Tremont St. is 51.9 acres, of which 5.5 acres is street surface which should go into the high-level system.

The time of concentration at Tremont St. is about thirty minutes, allowing six or seven minutes initial time for water to reach the drains. This corresponds to a maximum rainfall rate of 2.5 in. per hour, or 2.5 sec.-ft. per acre. Figuring in the ordinary way by the rational method, omitting all street surfaces which go to the high level, and making reasonable allowance for future development, we get a run-off factor of 0.682. This applied to the rainfall rate of 2.5 ins. gives 1 705 sec.-ft. per acre. Applying this to the capacity of 140 sec.-ft. assumed for the sewer in Tremont St., shows the area which can be taken in at this point is 81.1 acres.

There are about 37.5 acres, total area, remaining to be taken in.

When all lines are built to connect up this additional area, the resulting net tributary area at Tremont St. will be about 82.4 acres.

The pumping station is located at the corner of Union Park

and Albany streets. There are installed therein three 36-in. submerged centrifugal pumps, each of 67.7 sec.-ft., or 30 000 gals. per minute capacity, and one 26-in. pump with a capacity of 33.3 sec.-ft., or 15 000 gals. per minute, against a static head of $13\frac{1}{2}$ ft.

The total capacity of the station is 236.4 sec.-ft., or 105 000 gals. per minute. Regarding one 36-in. pump as a spare, the normal capacity of the station is 168.7 sec.-ft., or 75 000 gals. per minute.

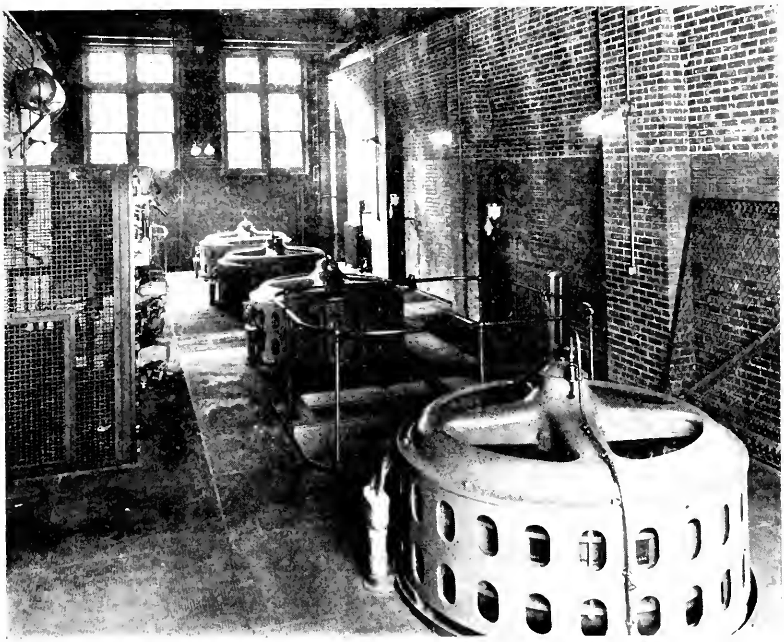


Fig. 4. Motor Room of Sewage Pumping Station.

The pumps are electrically driven. The motors for the 36-in. pumps are 150-brake h.p., constant speed, squirrel-cage induction motors, having a synchronous speed of not more than 200 revolutions per minute, and a full load speed of about 194 revolutions per minute, when supplied with 3-phase, 60-cycle alternating current at 440 volts at the motor terminals. (See Fig. 4.)

The 26-in. pump has a similar motor of 75 h.p., having a synchronous speed of 240 revolutions per minute and a full load speed of about 233 R.P.M.

The total power required for the station, including the spare pump, is 525 h.p. The pumping machinery is automatic throughout, each motor being controlled by a float which throws a switch at a certain fixed elevation of the sewage in the pump-well.

The foundation for this station presented an interesting problem, the underlying material, shown by borings, for 37.5 ft. below street level (elevation 20.00) being a soft silt, except for a few feet of gravel, clay and ash filling on top. Then a stratum of 3.5 ft. of stiff blue clay was found, under which a soft clay or silt extended to hard bottom at a depth of 80 ft.

Two plans naturally suggested themselves; first, to drive comparatively short piles, stopping them in the stiff clay stratum; second, to drive long piles and trust to friction.

To test the practicability of the latter scheme it was determined to drive a test pile, allow it to rest a day or two and then load it until it yielded to determine its actual bearing strength. The results of the tests are shown by Fig. 5.

A pit was dug on the site of the proposed station and to the proposed grade of the foundation, and a test pile was driven 25 ft. below the bottom of the pit, the fall of the hammer and the resulting penetration being recorded for each blow. A long rod was driven into the head of the pile for convenience in observing settlement, and the pile was capped with a block of concrete. It was then loaded with pig-iron in 5-ton lots, with the following results:

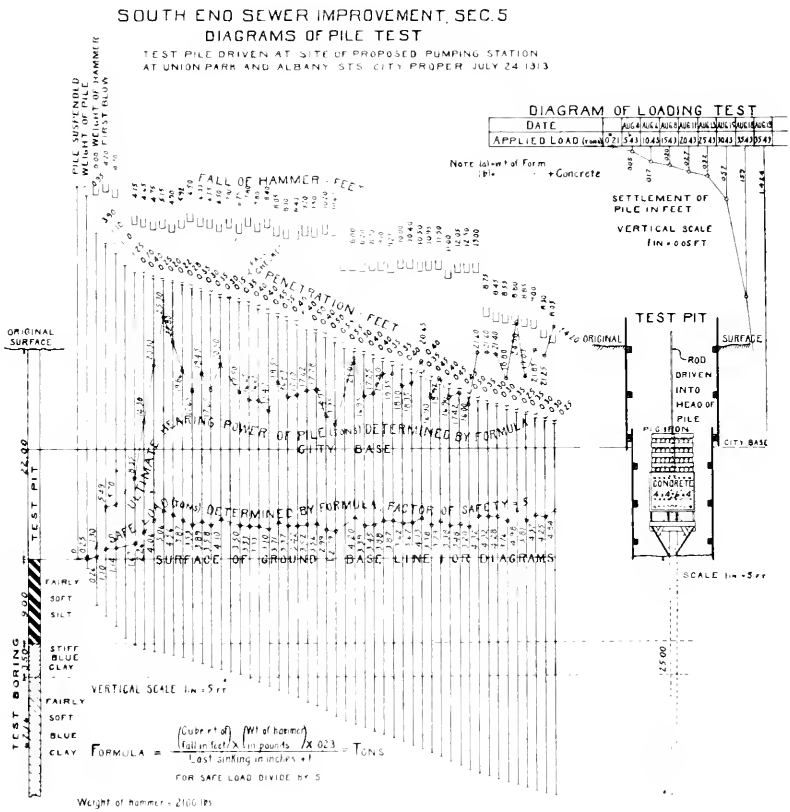
Date.	Total Load, Tons.	Settlement. Feet.
	0.21	
Aug. 4, 1913.	5.43	0.005
6, 1913.	10.43	0.017
8, 1913.	15.43	0.020
11, 1913.	20.43	0.027
13, 1913.	25.43	0.032
15, 1913.	30.43	0.057
18, 1913.	35.43	0.159

At 25 tons loading, the yield began sensibly to increase.

The pile formula, —

$$\frac{(\text{Cubic root of fall in feet}) \times (\text{Weight of hammer in lbs.}) \times (0.023)}{\text{Last sinking in inches} + 1} = \text{safe load} \times 5,$$

gave about 4 tons as a safe load.



F.G. 5.

It is a question whether any pile formula is applicable to a case like this, in which the pile does not bring up on anything resembling hard bottom. This pile, driven 25 ft. below the proposed grade of the foundation, of course pierced the clay stratum. It showed a little more resistance when going through

it than when driven its full length. The problem was indeterminate, and its solution became a matter of judgment. It was the writer's preference to drive short piles, stopping them in the clay stratum, but this view did not prevail. Inasmuch as the pit for the substructure was to be sheathed with 6-in. grooved and splined Georgia pine, driven to the clay stratum, and therefore enclosing the soft material in a tight box, and as the founda-

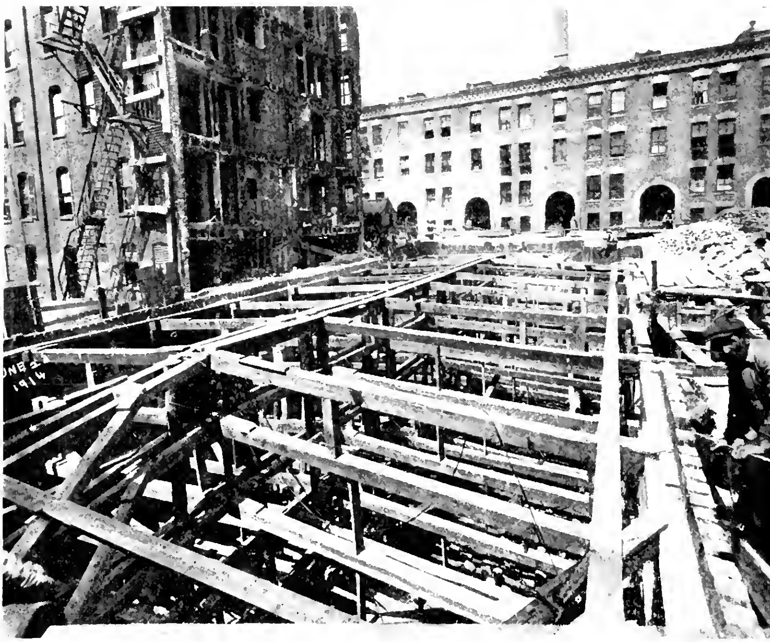


Fig. 6. Excavation at Pumping Station Site, showing Uplift of Bracing.

tion was to be a raft of reinforced concrete, $2\frac{1}{2}$ to 3 ft. thick over the whole area of the box, it was finally determined to drive 25-ft. piles which would result in a load of 8 tons apiece.

The pressure on the sheeting was severe. The excavation was braced to a row of piles driven along the center line and was well cross-braced, horizontally and vertically. The piles started to rise in the center as indicated in Fig. 6, but this was checked by the prompt completion of the concrete foundation.

The concrete of the substructure was waterproofed with the Kennelly integral waterproofing, a liquid substance which is applied by mixing it with the water in the concrete. It is successful up to date, a few small leaks having developed, but having been stopped.

The superstructure is of brick, with a reinforced concrete roof, waterproofed in the same way, tarred and graveled.

The station was planned to have not only ample but some surplus capacity, for several reasons. First, the limits of the ultimate extension of the pumping system are indeterminate. There is every gradation in the amount of suffering or inconvenience which has been experienced. The localities which, in the judgment of the Sewer Division, most needed relief have been selected, but there are undoubtedly many others which are now excluded which will demand and receive the benefit of the new system. This conclusion is rendered more probable from the fact that a singular difficulty was encountered in investigating the conditions in the South End. It was anticipated that many people would claim to have suffered more severely than they really had, and demand that the benefit of the new system be extended to their premises, when it was doubtful if it was really necessary. Just the reverse was found to be the case, owners denying having had trouble even where it was known that the premises were subject to flooding. The explanation is that the whole region being depreciated by the very condition for which a remedy was sought, the estates were unprofitable as investments, were probably heavily mortgaged, and the owners feared that their small remaining equities would be wiped out by a heavy sewer assessment. Such an assessment would be unjust, because the city is now only tardily making good a service which it should have rendered always. If this view prevails, then, as soon as it is known that the benefit does not entail an assessment, and the benefit to those estates which are connected are observed, demands will be made for considerable extensions of the system.

Another reason to expect additional demands upon the system is found in the location of this Union Park St. system, between the Dover and Dedham streets system, in which toler-

able conditions are maintained only by open connections with the intercepter. Now this sewer is too small for its present duty north of Dover St., and plans have long been in readiness for rebuilding or supplementing it. When this is done, as it must be very soon, the flow in the intercepter will be increased south of Dover St., and it will give less efficient aid in holding down the level in Dedham and Dover streets. Resort will then, of course, be had to the pumping station to help out these two systems in extreme cases of rain at high tide. Surplus capacity, which can be applied to helping out the worst portions of the Concord St. district, in addition to those already taken in, may also obviate the necessity of building another pumping station on that system, if the relief already given by the enlarged outlet, previously described, does not prove adequate.

As previously related, the station was put in operation just before the phenomenal rain of the first of last July. This rain was certainly all that could be desired as a test, and the station handled it successfully and easily, only two pumps, the 26-in. and one 36-in., being called into action. But the tide, although in, was falling, and not particularly high, being at 9.40 at the beginning of the heavy downpour and at 6.50 at the end. The real test will come with a heavy downpour and unusually high tide.

The contract price for the machinery was $34 856. The building, including substructure, cost about $50 000. The total cost of the project, sewers and all, to date, is about $400 000. Extensions now in sight may add $125 000, making a total cost of $525 000.

The construction of the sewers began in 1912, contracts for the machinery and station were let in 1913, and the station is now in commission, and is the largest station of its kind in the world.

Vol. II DECEMBER, 1915 No. 10

BOSTON SOCIETY OF CIVIL ENGINEERS
FOUNDED 1848

PAPERS AND DISCUSSIONS

LAYING A SMALL CAST-IRON PIPE ACROSS A NARROW STREAM.

By Charles R. Gow,* President, Boston Society of Civil Engineers.

Some years ago the writer had occasion to lay an 8-in. cast-iron pipe across a narrow stream. The pipe crossing was intended to form a part of a sewer line and had, therefore, to be laid to an established grade.

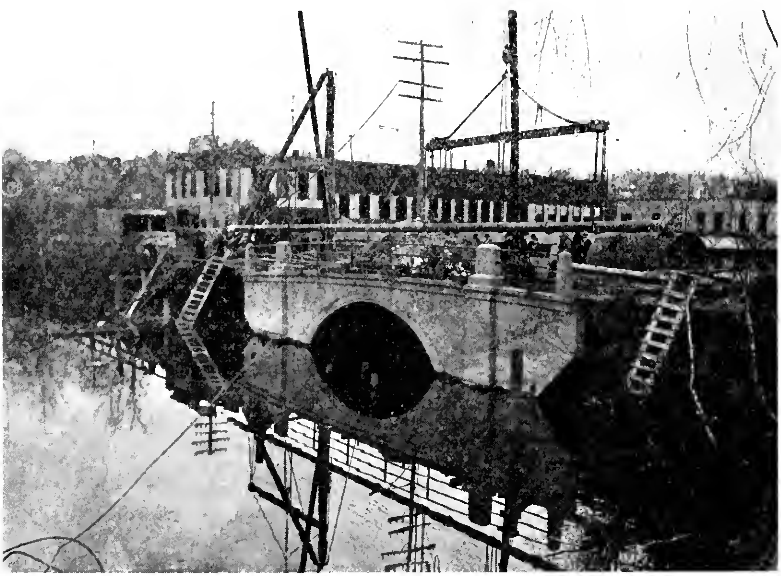
The stream was approximately 75 ft. in width and about 5 ft. in depth at the time when the work was done. As the river was used for boating, no obstruction which would interfere with such use was permitted. The bed of the stream was gravel overlaying a deposit of mud. The crossing was located close to and parallel with an existing highway bridge, from which all of the work was carried on.

A platform steam derrick mounted upon rollers was erected on the bridge so that it could be moved back and forth as the work progressed, the boom being long enough to reach out over the pipe location. A small orange peel bucket was used to remove the gravel slopes at either bank as well as to dredge the shallow trench necessary for the pipe. A pair of wooden leads containing a pile-driving hammer were suspended from the boom end, which was securely guyed in position, while spruce piles were driven in bents of two, the same being spaced 3 ft. on centers. There were 22 piles or 11 bents required in all.

* Charles R. Gow Co., General Contractors, Boston.

It was necessary to cut and cap the piles at an exact grade, and as the cutting point was more than 5 ft. under water, the following method was devised to accomplish the purpose:

A light riveted steel cylinder 6 ft. in diameter and 10 ft. in length was lowered over a bent of two piles until it rested vertically upon the bottom. To seal the bottom edge, some sand and gravel was deposited around the outside. A pulsometer pump was then swung out by the derrick, the suction lowered into the cylinder, and by means of a steam connection



with the hoisting engine the water was removed from the interior of the cylinder so that men could enter, cut the piles with an ordinary cross-cut saw, and cap them at the required grade with 6-in. by 6-in. timbers. When this operation was completed, the cylinder was withdrawn and placed over the next bent of uncut piles.

When all of the pile bents had been thus capped, the pipe was assembled on the bridge, the joints leaded and calked, and by means of the derrick and a guyed gin pole, the entire length

of pipe was suspended over the desired location and lowered through the water till it rested on the pile caps previously placed. A diver was employed to wedge the pipe securely in place, this being the only part of the work on which a diver was used. The pipe was then backfilled with some of the dredged material.

The entire cost of this work exclusive of the cast-iron pipe and lead for joints was five hundred sixty-one dollars.

The accompanying illustration shows the pipe about to be lowered into place. The cylinder which was used for a temporary cofferdam in which to cut the piles is seen in the background. The photograph also clearly shows the method of suspending the pipe to avoid unduly straining the joints.

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PAPERS AND DISCUSSIONS

EXTERNAL CORROSION OF WATER PIPE BY SULPHURIC ACID.

By Harrison P. Eddy,* Member Boston Society of Civil Engineers.

A rather unusual accident to the China Lake intake to the pumping station of the Kennebec Water District, Waterville, Me., has been brought to the attention of the writer. This 20-in. cast-iron pipe crossed over a small vitrified pipe which was used to convey the drip and waste sulphuric acid away from a shoddy mill. The vitrified pipe apparently was broken or clogged so that the acid escaped from it into the ground in the immediate vicinity of the main. An irregular hole about 2 in. by 1 in. was eaten entirely through the cast-iron pipe. At the edge of the hole the thickness of the pipe was not over one eighth of an inch, although this thickness gradually increased as the distance from the hole became greater. The effect of the acid on the outside of the pipe was noticeable for a distance of about three feet along its axis. The action of the acid upon the iron was greater in some places than others. There were several large bands of corrosion about the underside of the pipe, some of which were three or four inches wide, and apparently the pipe was being eaten into to a depth of as much as three eighths of an inch. The surface of the pipe, aside from the general irregularity of the bands and large areas eaten by the acid, was slightly rough but

* Of Metcalf & Eddy, Consulting Engineers, Boston.

not materially different from the surface of ordinary cast-iron pipe. It was nowhere honeycombed as might be expected.

The pipe was repaired by surrounding the portion affected by a split cast-iron sleeve four feet in length, packed with rubber gaskets and bolted together. The ends of the sleeve were leaded and calked in the usual way. At first the sleeve leaked at the joints, but these leaks stopped within twelve hours and the sleeve was entirely surrounded with Portland cement concrete well reinforced. The concrete sleeve was extended far enough in either direction to make certain that it protected the iron from any acid in the ground.

The vitrified acid pipe was diverted to a new location at some distance from the intake pipe. The soil in which the cast-iron pipe main and the vitrified pipe were laid was a mixture of sand and hardpan, fairly impervious to water, and not virgin soil, as there had been an old tannery in this location and various logs and timbers from the tannery were encountered in the excavation. Immediately below the vitrified pipe, a coarse water-bearing gravel was encountered. It is probable, however, that this stratum of gravel was fairly well cut off from the soil above by moderately impervious material.